FEBRUARY 1970 50 CENTS

Popular Science

THE *What's New* MAGAZINE

Your First Look at Detroit's Mini-Compacts

GM's XP-887

AM's GREMLIN

FORD'S PONY

ALL IN THIS ISSUE

Smokey Yunick Answers Your 8 Most-Asked Questions About Your Car

Surprising Facts We're Learning from the Moon Landings
By WERNHER von BRAUN

The Case of the Agile ATVs
By ERLE STANLEY GARDNER

Are You Ready for Your Own Sauna?

Scuba Diving for Fun
By COMMANDER SCOTT CARPENTER

How Science Gives You a New Edge on Shaving

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HOW WE HAVE GROWN!

A Personal Message from the Editor

ERNEST V. HEYN
ASSOCIATE PUBLISHER AND EDITOR-IN-CHIEF

Dear Reader:

One way we have grown is obvious--the size of our page--89.3 square inches compared with the previous 59.3 square inches.

Another way we have grown: When I became editor of POPULAR SCIENCE five years ago we had a circulation of 1,280,000. Now we are up to 1,625,000, a 27 percent gain.

Before I review the advantages of the larger page size, I want to repeat that we will celebrate our 100th birthday in 1972 and that we have the longest history of continuous publication of any man's magazine in the U.S.A.

As I wrote you last month, you and people like you must have liked what you found in our pages to have kept us in business so long. And you have helped us grow by letting us know through your letters--and our research--what changes you have wanted in POPULAR SCIENCE to meet your changing needs in a rapidly changing world. As a result we have grown in two other ways; we were first in our field to offer full-color illustrations and photographs every month in our editorial pages. We introduced "perfect binding" which permits the magazine to lie flat on your workbench or desk.

Another way we have grown: a remarkable series of articles by outstanding authors and authorities: Dr. Wernher von Braun, Cmdr. Scott Carpenter, Erle Stanley Gardner, and Smokey Yunick plus a roster of great exclusive contributors including C. P. Gilmore, Phil McCafferty, Robert Gannon, R. J. De Cristoforo, and Jackson Hand.

What does this growth in our page size mean to you? We are offering you, beginning in this issue:

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We of the editorial staff feel that the larger POPULAR SCIENCE is an exciting innovation. We all hope it will be a rewarding experience for you in the months and years to come.

Sincerely,

Ernest V. Heyn
Editor-in-Chief

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THE *What's New* MAGAZINE™

FEBRUARY 1970 Founded in 1872/Vol. 196 No. 2

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Detroit's New Mini-Compacts By JIM DUNNE PAGE 52
Really small U.S.-made cars are on their way! PS' Detroit Editor reports full technical details in this exclusive sneak preview.

SMOKEY YUNICK Answers Your Eight Most-Asked Auto Questions PAGE 58
The country's top auto mechanic lets himself go and gives you the straight dope—in depth—about your most common car problems.

Surprising Facts from the Moon Landings By WERNHER VON BRAUN PAGE 62
Why did the moon ring like a bell? Apollo discoveries are proving to be a treasure of new information for us.

Case of the Agile ATVs By ERLE STANLEY GARDNER PAGE 70
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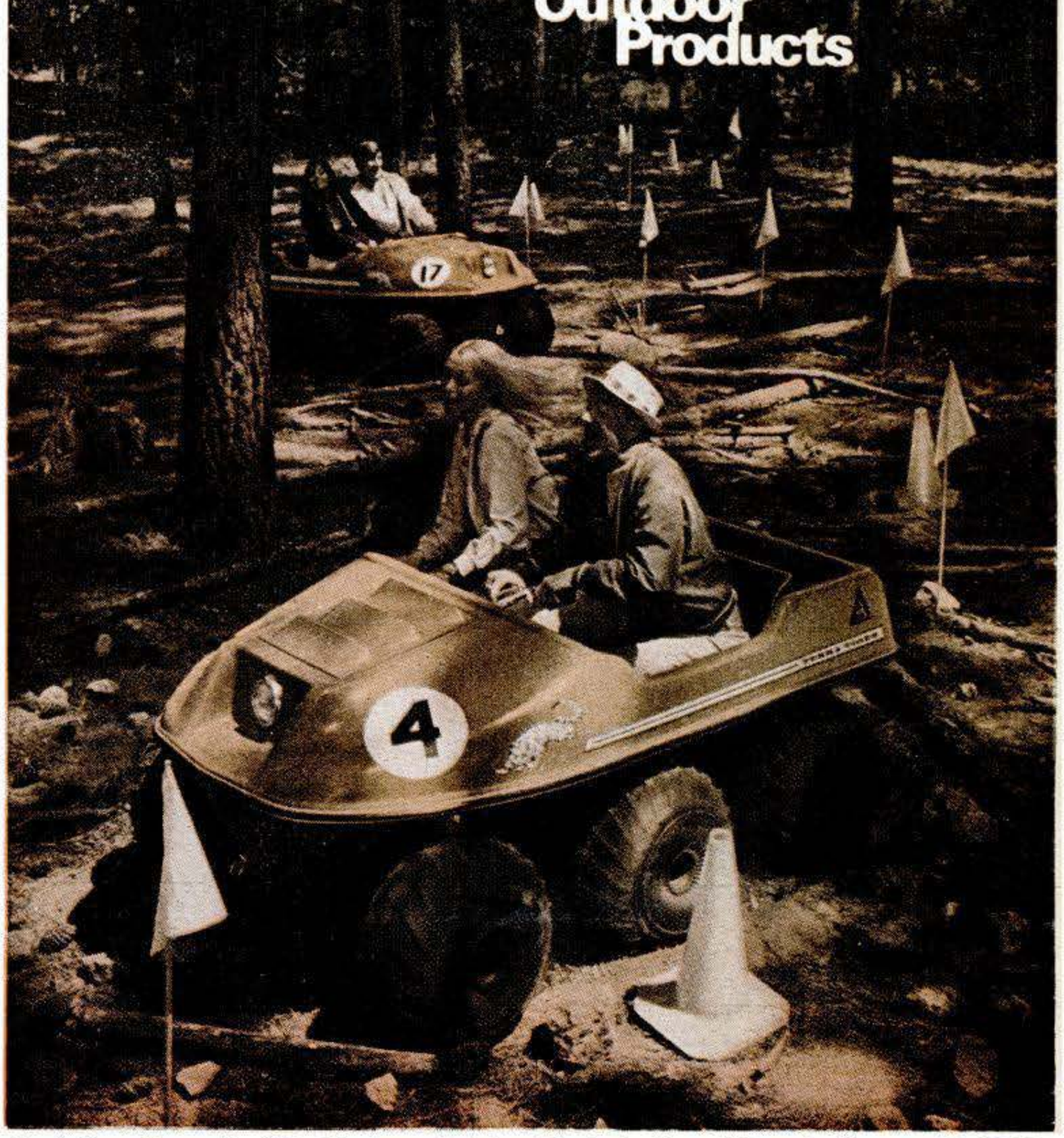

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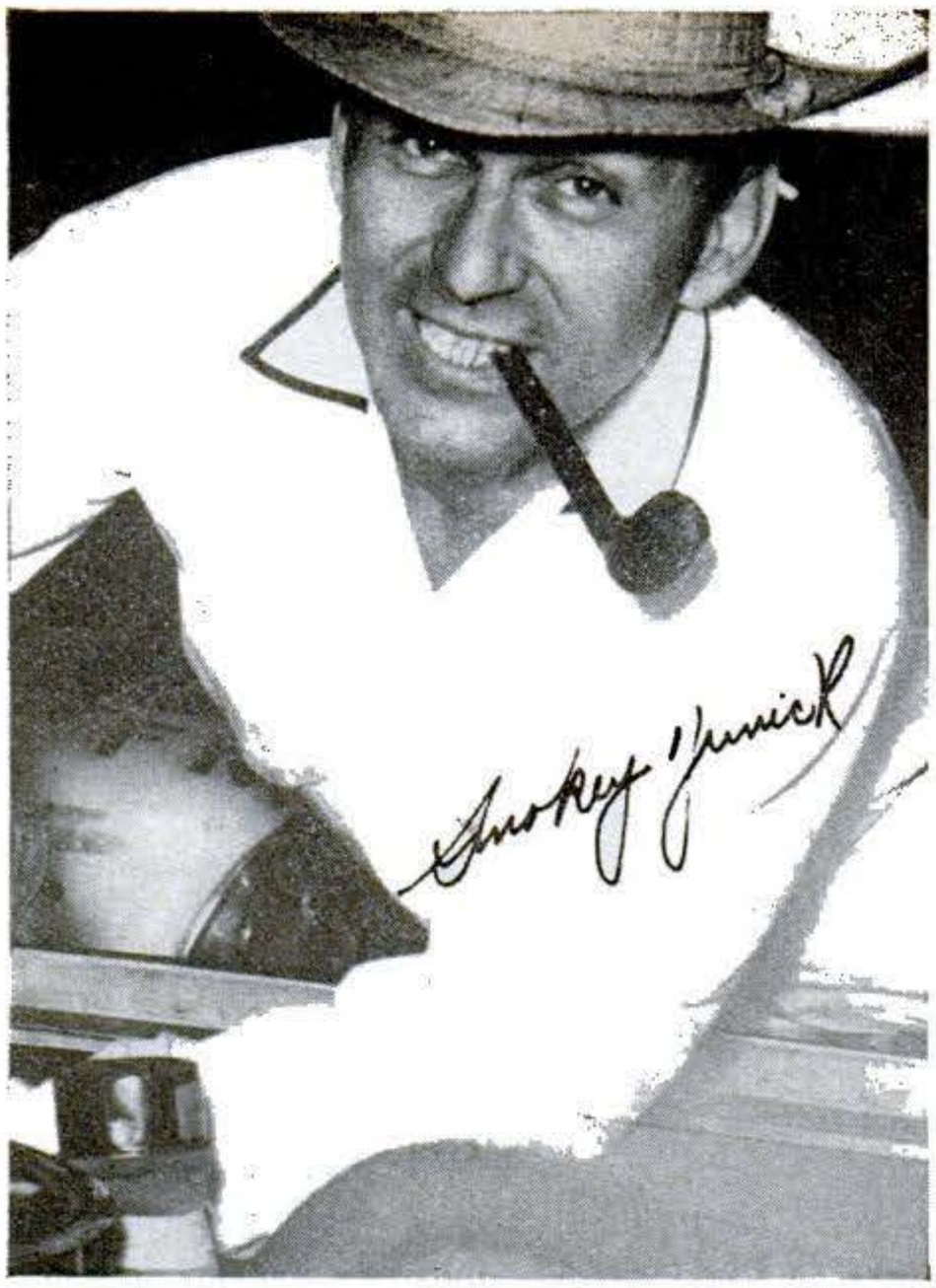

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Plenty! If you're a man who wants the news and know-how to keep up to date in a complex world, take a look at some outstanding features in March Popular Science:

What Is Congress Doing About Safer Products for Your Home?

A look at the tools and appliances you use every day—and what's being done to reduce their hazards for you and your family

How Apollo 13 Will Probe the Moon's Interior

Wernher von Braun takes you behind the headlines for the detailed story of our next project in space

Engineering the Mechanical Heart

Curtis Mitchell reports on the fascinating search for a major medical miracle

Now the Wankel Is Ready for Your Future Car

Development of this amazing power plant has reached the stage where it is a serious contender as your next auto engine

We Hit the RV Trail!

Personal-use reports on six different kinds of recreational vehicles

The Crazy, Tricky, Wonderful Sport of Island-Hopping

Step aboard for a wacky air cruise of the Caribbean

Vacation Homes by Mail

Darrell Huff tells you about the latest way to buy your "second home"

Things You Can Make

- A High-Pressure Car Washer
- Your Best Fishing Rod
- Screw Threads in Wood
- A Unique Patio Table

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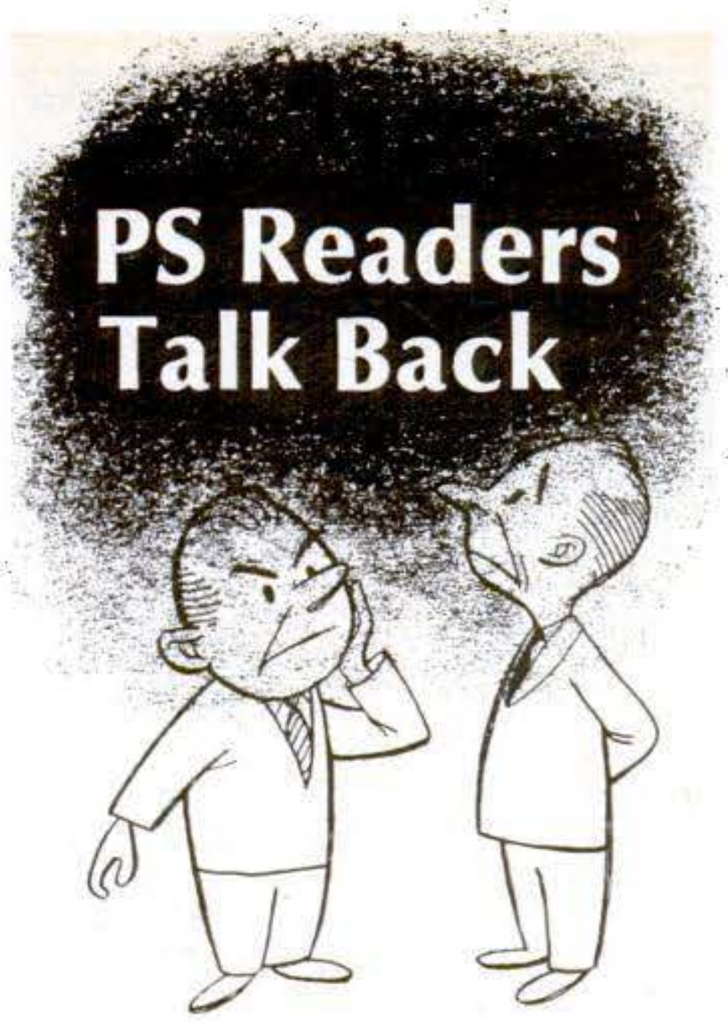


Pollution fallout

In "World's Tallest Chimney" [Dec.] W. Stevenson Bacon claims that this remarkable structure is "a frontal attack on air pollution." I don't see how simply lifting the pollutants above the clouds helps solve this problem for anyone except the people who live near the Mitchell stack. The pollutants are still being poured into the air, but now they can be blown away to become somebody else's problem. When large sums of money are being spent for "solutions" like this, how can we ever expect the air on this planet to become any cleaner?

JAY A. GARRISON
Knoxville, Tenn.

. . . You erred with regard to the atmospheric phenomenon known as inversion. Normally the temperature of air decreases with height. When the temperature of the air increases with height, or decreases less rapidly than the normal lapse rate, we have what is known as an inversion; in which case, warm air caps colder air, not the reverse as Bacon says.

JAMES P. ORMSBY, Groton, N.Y.

Car fire extinguishers

In "How to Buy Home Fire Extinguishers" [Dec.], you say the "best place to stow a fire extinguisher for an auto is in the trunk." I disagree. The worst place to keep a fire extinguisher is in the trunk. The best place is on the floor next to, or behind, the driver's seat. The driver who is in a chain-reaction collision and is pinned in his seat, or whose trunk is smashed shut, would soon learn to love that ugly extinguisher right there where everyone can see it.

E. F. NOLTE JR., State College, Pa.

. . . You omitted mentioning the popular hand-pumping types which contain carbon tetrachloride. Why?

G. P. KATONA, New York City.

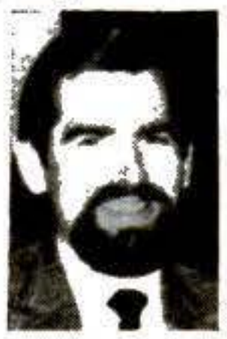
Carbon tetrachloride extinguishers have been delisted by the Underwriters Laboratories. Carbon tetrachloride may form poisonous phosgene gas within a closed area.

Skillful Driver Brings Mail

Here's something to do "If Your Headlights Quit" [Dec.]. I keep a roll of fluorescent tape in my glove compartment. If one of my headlamps or a taillight goes bad, I use the tape to form an X across the lens until I can make a replacement or repair.

ARTHUR J. MUNZER, Mount Kisco, N.Y.

. . . Thank you for the articles on skillful driving. Shortly after I read "What to Do If Your Hood Flies Open," in October, the hood flew open on my 1969 car—and only a few weeks after the hood latch had been replaced by the dealer in a recall campaign.



D. H. MCBURNEY
Pittsburgh, Pa.

Sees a rub in rubbing alcohol

In "Taking Care of Your Car" [Dec.], Jim Davis suggests the use of rubbing alcohol to absorb water in a gas tank. Rubbing alcohol is 30 percent water. A pint of alcohol would add 4.8 ounces of water to your fuel tank. It would be better to add absolute alcohol, which is available at most drug stores. It's water-free. A second choice is 95 percent ethanol, which is also available at drug stores.

C. S. ZAWACKI, Port Jefferson, N.Y.

. . . There's another way to rebuild a starter besides the method Jim Davis describes. The other way to get new brushes over the commutator is by pushing the brushes up far enough so that the pressure spring will catch the side of the brush. This will hold it until you have the brushes over the commutator, and the unit bolted together. Then remove the inspection cover, push down on the brushes with a screwdriver, and the spring will jump back into place.

KENNETH J. BORN, Ponca City, Okla.

What's wrong with CB

I enjoyed "CB Radio to the Rescue" [Dec.]. But I would like to point out that the CB bands are more often than not almost completely useless for any communication due to the "skippers" who use the band illegally. They also use illegal equipment and in some cases cause interference.

The CB operator must abide completely by FCC rules. CB radio is not a club. It is a public-service band, and is not to be treated lightly. Many people cannot handle the responsibility of the license and junk up the band for others. CB is not designed for everybody's use.

LEWIS E. MUNN
Hillsdale, Mich.

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. . . H.E.L.P. and R.E.A.C.T. are the desired purposes of an effective Citizens Band communications network, but first you're going to have to minimize the number of bootleggers who just clobber the frequency and violate the rules. These violations are heard all day on 11 meters.

RICHARD EBILING
White Plains, N.Y.

. . . Len Buckwalter errs when he says that "in Boston and New York, the United States Coast Guard monitors channel 13, the unofficial CB marine frequency, so even an outboard runabout can now have the safety of two-way radio." The U.S. Coast Guard does not monitor any CB radio channels.

G. F. HEMPTON, Capt. USCG
Chief, Communications Staff
Washington, D.C.

Likes European new-car service

Your article "BMW 2002: It's a Supercar—Bavarian Style" [Dec.] was especially interesting. Last summer, I bought a BMW 1600 in Munich. I was impressed that it came with a top-grade tire, reclining seats, and an FM radio.

Most impressive was the way delivery was made at the plant. The English-speaking mechanic carefully explained the vehicle and its operation. Then he gave us a card to get 40 liters of gas at adjoining pumps.

From this experience, it is understandable why foreign cars have become so popular.

FERDINAND L. COSTE, Holbrook, N.Y.

Shocking situation

I hope no Chevy owner bumps into a Ford owner, as you suggest [Dec., p. 170], to provide a ground when jumping a battery, because they are in for a shock. Cars with opposite grounding systems (positive ground in one, negative ground in the other) would short out and possibly ruin both batteries if this method were tried.

ED JODON, Plano, Tex.

Modern Fords and Chevrolets both have negative ground systems, as do other recent U.S. cars. Some European cars still have positive ground systems.

Standardized suspensions

It's ridiculous for all GM cars to have the same front suspension members by 1971 ["Detroit Report," Dec.]. The American people should protest. All it means is more money in the auto industry's pocket, and I as a consumer will be less satisfied.

The other manufacturers will certainly do the same thing. And I don't think standardization will stop here. The industry will try to do it with other components.

Frankly I think the car manufacturers believe they are the locomotive in a train and the American consumers are passengers who have to make a left when the locomotive makes a left, or a right when the locomotive makes a right turn. The passengers in the train should keep going straight and let the locomotive make its turns. After a while that locomotive will get lonely traveling by itself.

WILLIAM HALLERTON, Trenton, N.J.

Says we slipped on limited-slip

You did not tell the whole "Truth about Limited-Slip Differentials" [Nov.]. I would not deprecate their advantages in mud, or on steep rough roads where you can spin out on a rock, due to low-speed inertia. But on wet side-sloping road, or hillside off the road, the limited-slip will keep you from turning up the hill.

We have had to replace limited slips with standard differentials on our four-wheel-drive vehicles because they would not come around, even with front wheels powered. You have no control at all with chains on rear wheels. Yet in tough going when you chain only the front, all your power may be transmitted to the lighter front axle where the traction is—bang goes something.

KEN GARDNER, Grand Junction, Colo.

Although our story did not attempt to cover limited-slip differentials for four-wheel-drive vehicles, thanks for sharing your experience with our readers.

Dinghy Davits

In New Ideas from Inventors [Aug.], you showed a drawing of a davit for lifting dinghies onto cruisers. Your readers may be interested in knowing that we have been shipping our own Dinghy

Davit all over the world and have received compliments on its simplicity and ingenuity.

HAL DAUNIS, PRES. Dinghy Davit Co.,
Manhattan Beach, Calif.

Says Norbye rides high

PS Automotive Editor Jan P. Norbye is the greatest on anything that has to do with driving, testing, and choosing options for cars. I learned a lot from "How to Pick the Right Axle Ratio for Your Car" [Dec.]. And I learned that radials are the best in "What Goes On Inside of Your Tires." No other magazine gives so many accurate details. I wonder if Norbye has ever written a book on cars?

EDD VOJTAS JR., Pittsburgh, Pa.

Norbye has written two books on cars: "Sports-Car Suspension" (Sports Car Press, $1.95) and "The New Fiat Guide" (Sports Car Press, $2.45).

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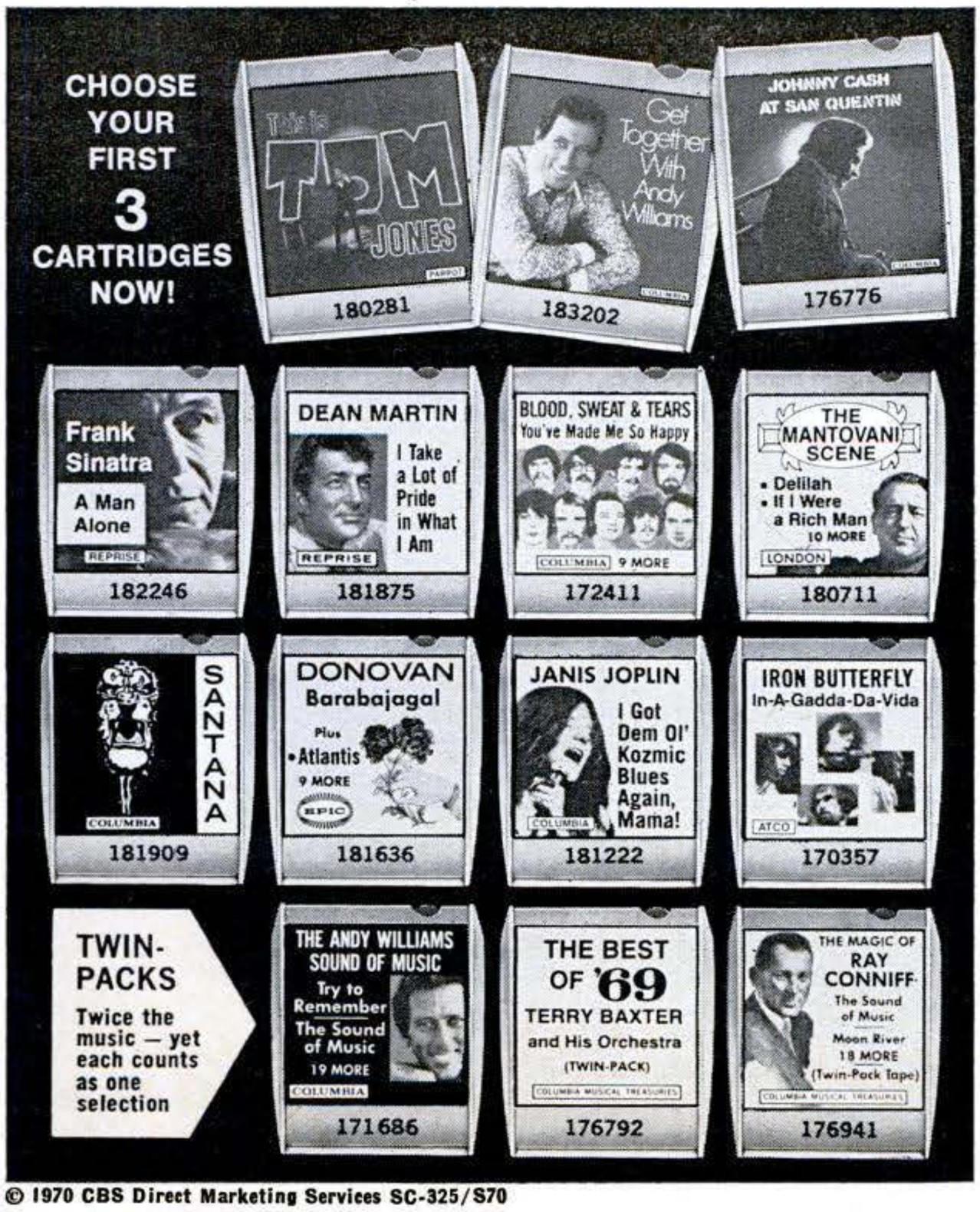

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By
DICK KOTIS
President
Fred Arbogast Co., Inc.

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Detroit Report...

CITROEN IS MAKING 500 WANKEL-POWERED CARS. Production began in the plant at Rennes last month. The engine is a 55-hp twin-rotor unit developed by Comotor in Luxembourg--a firm owned jointly by Citroen and NSU. The M-35 car will share some mechanical components with the Ami-8 sedan, but has its own distinctive styling. Top speed is about 90 mph, and the car will cover the standing quarter-mile in just over 20 seconds. The selling price of the M-35 in France will be about $2,700.

Watch for a sparkling new Javelin next fall. That will be Step Three in American Motors' announced plans to come out with a new car every six months for three years. The first was the Hornet, the second will be the Gremlin (see page 53). After the redesigned Javelin you'll see a midships-engined sports car, then the 1972 Rebel and Ambassador. The AMX/2 sports car will be built in Italy around a U.S.-made power train. The car will sell for about $5,000 when it appears as a 1971½ model.

Bendix says fuel injection will be adopted by most American cars within the next five years. Two developments make this swing away from carburetors inescapable, say Bendix spokesmen. One reason is the push for cleaner-running engines; the other is the low cost of the components that make up a modern electronic fuel-injection system. Volkswagen has been using a Bosch system on two mass-produced models for two years, and calls it an unqualified success. Bosch electronic fuel injection is now standard on certain models of Aston Martin, Citroen, Mercedes-Benz, Opel, Saab, and Volvo. First in the U.S.? It will be a 1971½ luxury car from Ford.

Some cars will shrink in the next few years. Detroit's swing to smaller cars will not be confined to adding sub-compacts and mini-compacts (see page 53). Some of the larger models will come down in size. Mustang is one example. While the 1971 Mustang will be longer than the present model, Ford is already at work on an all-new Mustang for 1973, using the same basic body as the Maverick. This will bring the Mustang down to the classic dimensions of European sports cars. Ford product planners knew they went too far with the 1971 Mustang when a prototype was placed side by side with a Torino. The two cars are practically the same size!

Volkswagen, king of the imports, is again selling strong after some setbacks early in 1969. Just when we began to get reports on the decline of the VW, the enigmatic little car was setting new all-time sales records. Total 1969 sales in the US will easily top half-a-million cars. In second place is Toyota, with about 120,000 cars sold here last year. While VW sales are practically the same as in 1968, Toyota shows an 80-percent gain in 1969, and has announced it's going after the Number One spot. The remaining leading import cars are, in order of unit sales for the 1969 calendar year: Opel, Datsun, Fiat, Volvo, Mercedes-Benz, Ford Cortina, MG, and Renault. The funny thing is that if ranked in order of dollar volume, Mercedes-Benz would be second only to Volkswagen! Chrysler's latest French-built Simca failed to get a big following here. Ford is aiming to increase its import-car share by selling the German-built Capri through Lincoln-Mercury dealers.

Cold statistics tell the story of why Detroit is going into the small-car business in such a big way. Sales of imported cars have risen from 6.2 to 11.4 percent of the total in the four years from 1965 to 1969. Moreover, this percentage is expected to increase in the first half of 1970. Meanwhile, sales of domestic compacts fell from 17.3 percent in 1960 to 6.7 percent in 1968. The growth of multicar ownership further strengthens the small-car market, since second and third cars are often small. Of all households in the U.S., 29 percent own two cars. About one million families own three cars, according to a recent survey.

Car thefts continue to rise, and if present trends continue, will reach a record annual rate of one million in 1970. That's a dollar value of $1.3 billion per year, according to a study by Chrysler Corporation. Along with car thefts, the loss of car accessories is also mounting. Stereo radios are the newest favorite of car strippers. And "add-on" stereo units are most vulnerable because they are easy to install, easy to remove. As cars become more theftproof, the Chrysler study finds, the chance increases that thieves will confront the driver personally, since they must get possession of the keys. In addition to all the usual "don'ts," Chrysler advises drivers to be extra cautious when parking near bowling alleys, theaters, night schools, and other places where the absence of the owner of the parked car can be timed.

Jim Dunne
Detroit Editor

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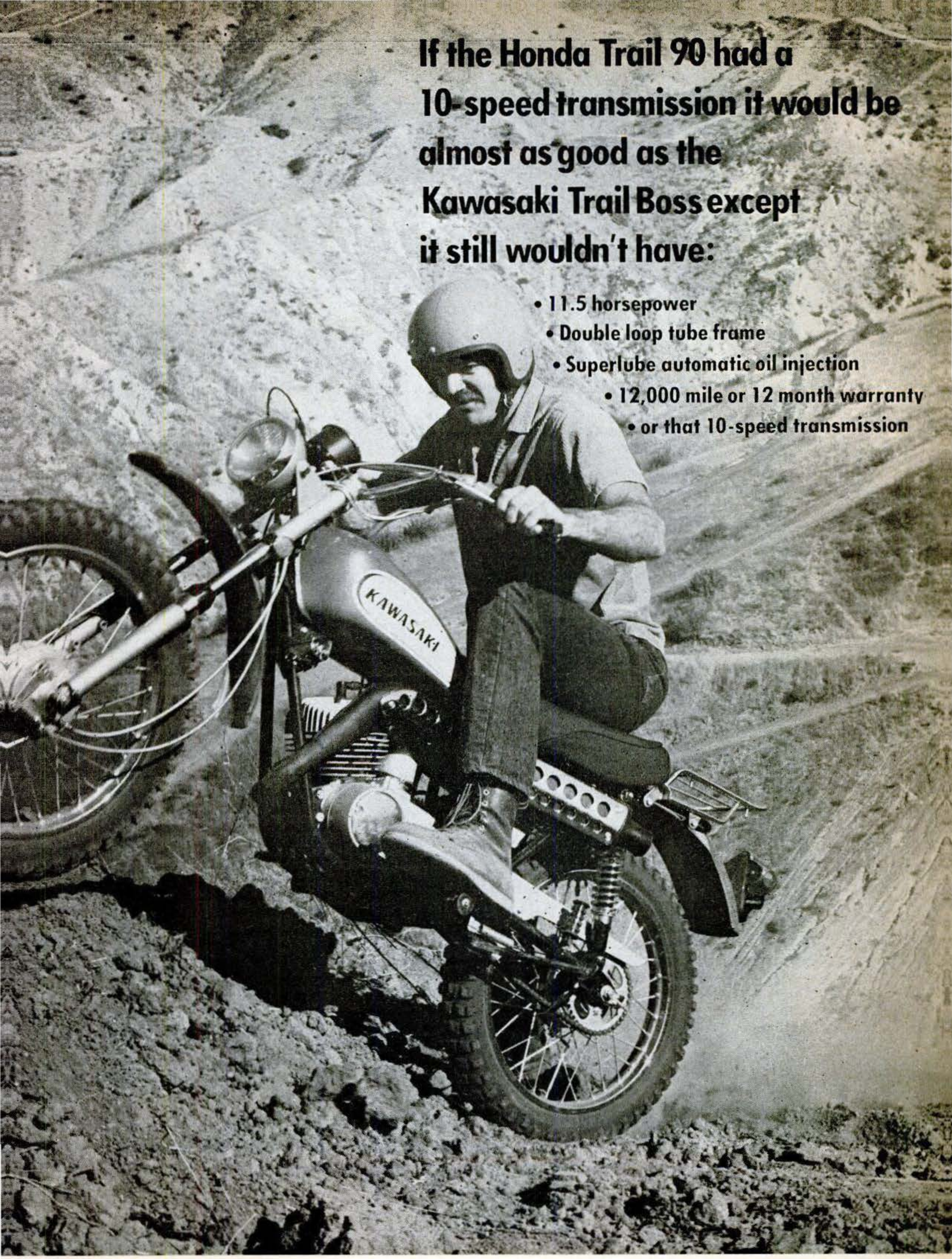

Kawasaki Motors Corporation, 1062 McGaw Avenue, Santa Ana, California 92705
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"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Ask Smokey. You'll find the address at the end of the column. Please *print* your name and address.

My 1968 Ford ¾-ton pickup with 10½-ft. camper on it has a 360 V-8 with New Process 435 four-speed transmission and 3.73:1 rear axle ratio. I'd like to increase the mpg and still increase the output. What effect would the things listed below have? Installing a four-barrel carburetor; dual exhaust system with straight-through mufflers and headers; different type air cleaner, and maybe even one of Borg-Warner's driveline overdrives.

T. A. ROBINSON, Columbia, Mo.

If you add the carburetor, exhaust set-up, and air cleaner you propose, you'll gain some horsepower. This will require more fuel, or at least as much as you're now using, assuming the engine is now running as it should be. To make power you have to make heat, which of course comes from burning fuel. It is possible that with the increased power you could then pull the overdrive, since you are geared very low. That would put you over more ground with less rpm. I'd say it's a good bet that you might get better mileage. But when you add up the cost of all that you propose, it may take you many, many miles to break even.

I've been trying to determine if a high-priced car is better mechanically than a low-priced one from the same manufacturer. For example, a GM Cadillac versus a GM Chevrolet. Like, will the big one go more miles at 65 than the little one? Will maintenance be less on the more expensive job? Is the Caddy motor built better than a Chevy of equivalent horsepower?

W. U. DAY, Neenah, Wis.

In the Caddy versus Chevy comparison, it's back to the old saw: You get what you pay for. In the big one you get more luxury, more room, more quiet, better ride. And it is built better—to a point. The big difference is in the body and chassis—not the engine. In other words, if a big Chevrolet engine were put in the Cadillac of a man just a little hard of hearing, I doubt if he could tell the difference. In the big, expensive jobs there is a lot more to spend on luxury factors, but very little goes into improving the engines, because it wouldn't be possible to have much closer tolerance, or better materials in them

Driving fast or slow, in city traffic or on the highway, there is an unbearable smell of gasoline in my '69 Ford Country Squire, 390-cubic-inch V-8. The company referred me to my dealer. The car has been to the dealer nine times but the smell is still there, and they really don't know what to do about it. can you help?

ALEXANDER SIRIO, Fort Lee, N.J.

You must have a leak in the gas-tank filler area, most likely in the vent system. The fuel is evaporating and the odor drawn into the wagon by air flow to the inside. You didn't say, but I'll bet it is at its worst when one or more windows are open. This is certainly no impossible fix for any competent shop.

I can't seem to keep the front wheels of my '65 Sunbeam Tiger aligned for more than a short period of time. They go out of camber. A friend who has the same trouble with his Tiger says the frame of the Alpine wasn't beefed up for the extra 400 pounds of weight from the Ford V-8, and constantly bends, so that the shims which the alignment man put in are only a temporary remedy. If this isn't the explanation, please tell me what is—and what's the remedy?

P. DRAPIEWSKI, W. Manicoke, Pa.

When a car loses camber, either the front springs are sagging or something is bending. I hope you haven't found out which, yet, the hard way—on the road. Seems you'll have to find some alignment man who is willing to go farther in beefing up than just a few shims.

We plan to buy an International Scout with four-cylinder engine, four-speed transmission, and two-wheel drive. Which rear-axle ratio—3.73, 4.27, or 4.88 to 1—would be best for traveling and getting top speeds without wear and tear on the engine?

DAVE RITTGER, River Edge, N.J.

If you use the standard tire size, 3.73:1 would be your best bet. If you up tire size, you had better put in the 4.27:1 ratio. That engine rates only 110 hp. at 4,000 so it can't handle high gearing.

For two years, my '65 Cadillac had a hesitation in the engine, much as if the key were turned off, then back on. The Cadillac service people and a local ignition specialist have done their best, without result. A diagnostic center nearby discovered nothing wrong, but on a test drive, they noted a catch each time they turned a corner. They "guesed" this fault was in the wiring between the key and the coil, but did not correct it. The trouble is getting worse lately. It happens on hitting a bump or taking a curve at any speed to 70 mph. Any answer?

E. WINCHELL, Ridgewood, N. J.

It seems pretty certain that this is from ignition. What I would do is make a temporary, simple ignition system, that bypasses the original system, in the faulty area. Run it an hour or so this way. If the shunt corrects the trouble, then I'd start back-checking from the battery cable. The battery cable can look good and test all right, but should be shaken and pulled to reveal a bum connection internally to the terminal lug. Check on through this way until you find the fault. I'll bet it turns out to be some kind of weirdo that's hard to find.

What I dislike is the roaring motor on my 1968 Tempest-LeMans 8, purchased new. Can something be done to reduce the roar, such as change muffler, exhaust pipe, or . . .? The dealer gives me no satisfaction.

LOUIS J. MANCUSCO, Washington, D.C.

Maybe I'm hard of hearing, but I don't think that normally that car or engine is extra noisy. I believe you have either a leaky exhaust system somewhere down the line, or a bad muffler. Try another dealer.

Is it okay to static-time Detroit cars? The cost of a little bulb and a piece of wire sure beats the cost of a timing light. If it is not okay, why? VW and other European cars specify static timing. I enjoy your column.

ROBERT D. NELSON, San Diego, Calif.

If you expect to compensate for gear and chain sloppiness, as well as advance, you'll have to have a timing light. Twenty years ago you could get by with static timing, but American cars are way past that stage now. It's true that lots of race cars are still timed with the wire and the bulb, but it's because of the mechanic's vast experience in timing the same engine, from too-late all the way to a hole in the piston.

At about 55 mph, a vibration sets in that makes my Powerglide-equipped '62 Chevy II six shudder. It vibrates even worse if you ease off on the accelerator. Take your foot off the pedal entirely, or tromp it down, and the vibration subsides, though as the speed increases again, it returns. Shutting off the engine during the vibration does not cure it. Tires are new and balanced, alignment and wheel bearings good. Shocks and U-joints check out okay, too.

GARY JOHN KUENZLE, Milwaukee, Wis.

You have an imbalance problem, that's for sure. I believe you can pin down

[Continued on page 14]

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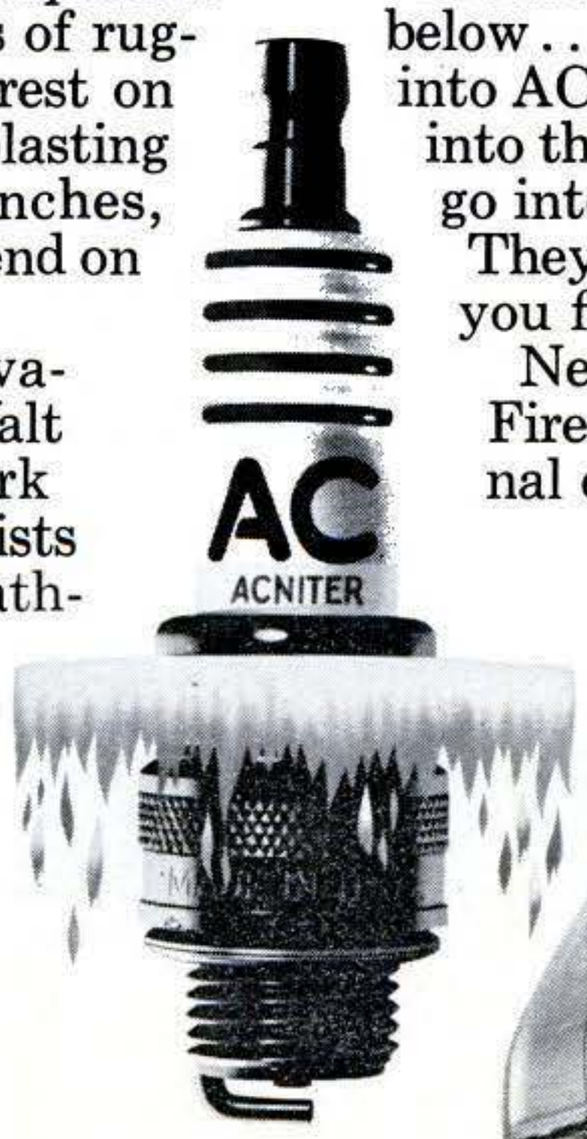

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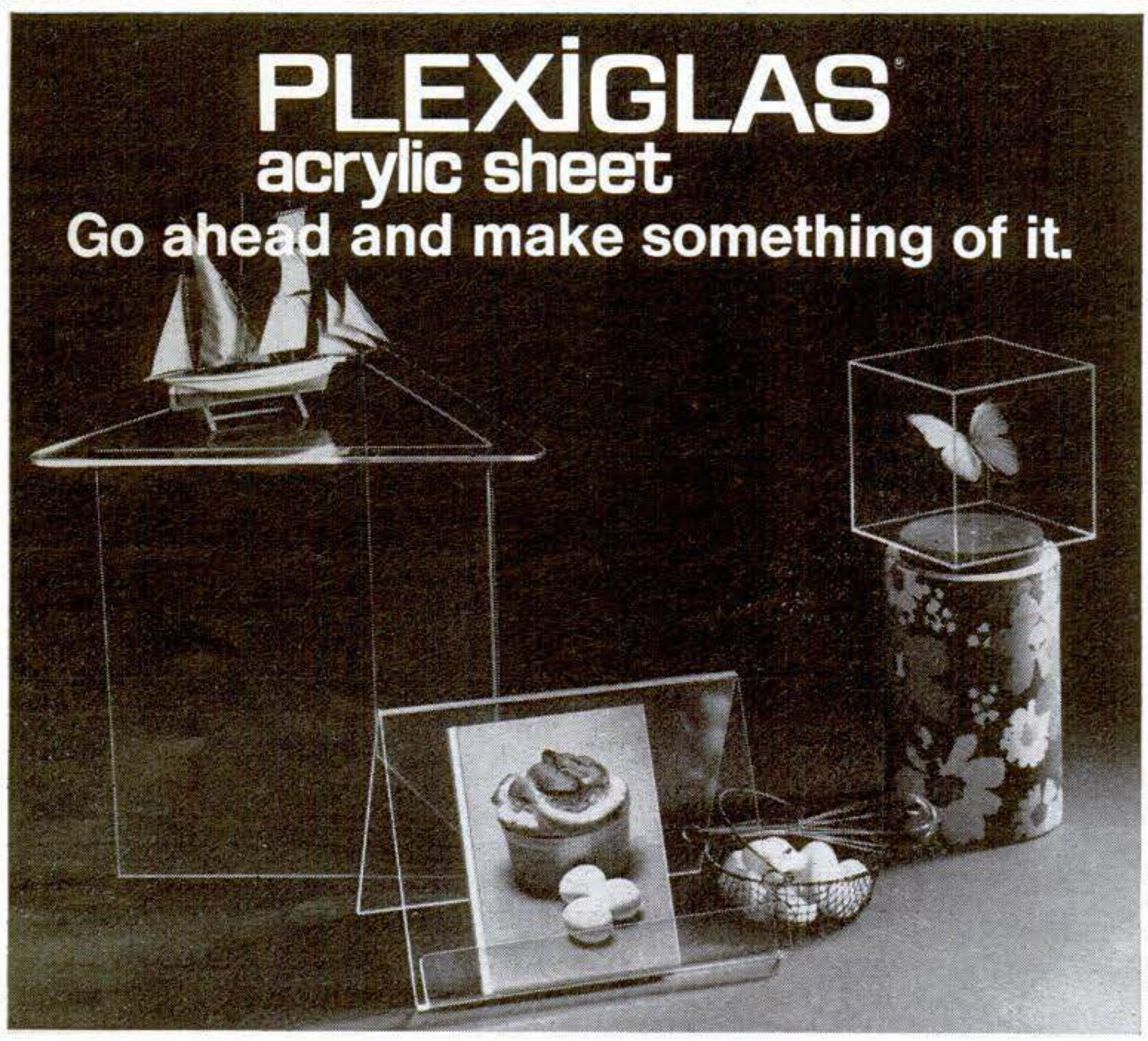

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"Say, Smokey . . ."

the cause in an elimination process. Can you get it to vibrate by slowly easing the throttle sitting still in neutral? *If not, remove the drive shaft and put the car in* drive *and try it then. If it doesn't vibrate that way, then install the shaft again, and try it with the wheels jacked up. By this time you should have the trouble pinpointed.*

I have a Ford Falcon '67 sedan with automatic transmission and 120-hp. engine. Is there anything that would quicken the steering, which is abominably slow at 5½ turns lock to lock? Would a two-barrel carb help lessen the flat spot in acceleration when it upshifts from second to high?

R. M. GEISMAN, Rosyln Heights, N.Y.

I believe you might get a Mustang steering gear in there without too much trouble to quicken the ratio. But the system might require too much effort for manual steering, so check the power-steering boxes for that car. On your lag, you may help it some with the two-barrel carb, but your real problem is too much weight for too small an engine with too-high gearing.

My 1968 Buick Le Sabre 400 gets 13-14 mpg. after tune-up, but plugs and points only last 5,000-6,000 miles, and I'm back down to 8-10 mpg. I plan to install a Motorola CDI system at a cost of $75. Will this extend the life of plugs and points sufficiently? What trouble do you think it might give?

WAYNE KINSEY, Denver City, Tex.

This will probably help your spark-plug life, and of course points are out of the picture. Any mileage gain would be only because the CDI system either operates like new, or not at all. Starting would be better, and as far as problems are concerned I doubt that that system would ever require maintenance.

My problem is a '62 Mercedes-Benz 220-b, OHC-6, with 65,000 miles on it. The engine ran hot to the point of seizure due to a leaking radiator hose. A mechanic pulled the head, replaced six burned exhaust valves, shaved the head to the maximum amount (due to warp) and reassembled it with two head gaskets. The car runs all right, except that water leaks into a cylinder, causing it to miss until the engine warms up. So the muffler has rusted out from the water. Two other mechanics that I have talked with advise putting on a new head. What do you think?

HARRY E. DIECKMAN, Harvey, La.

I have never had much luck with short cuts or economy fixes, and you won't either, if that head turns out warped or cracked. I'm afraid you'll end up replacing that cylinder head or stay in trouble, for the double head-gasket job is not a true fix.

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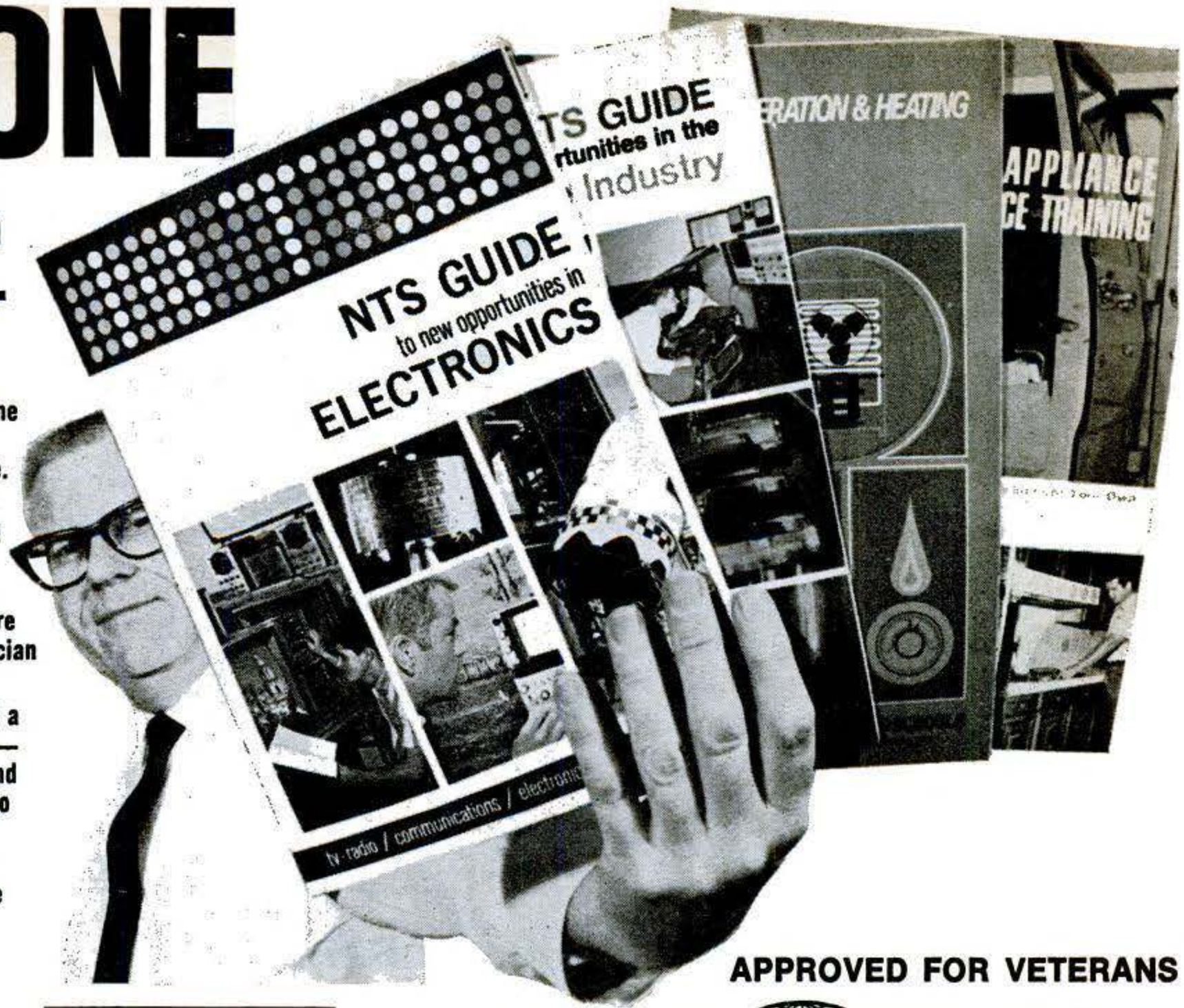
TAKE ONE



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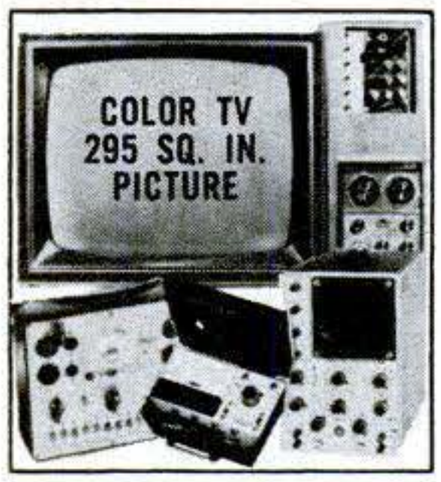

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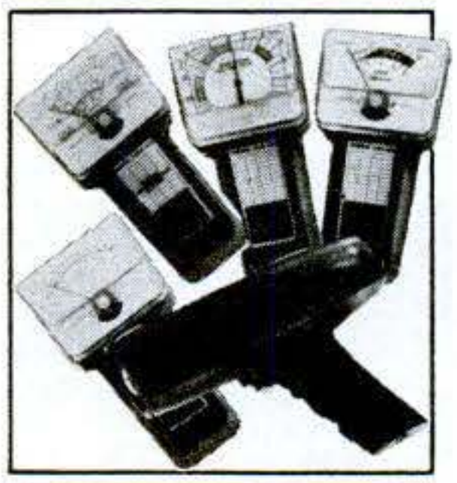

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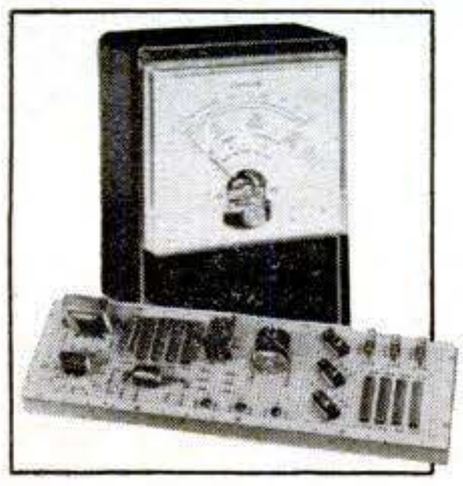

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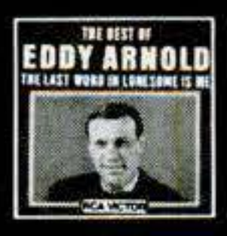

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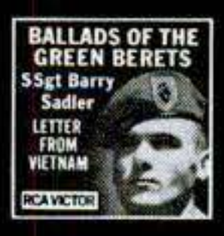

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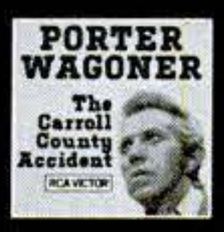

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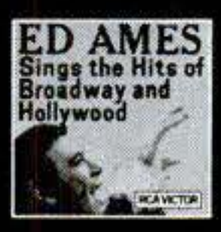

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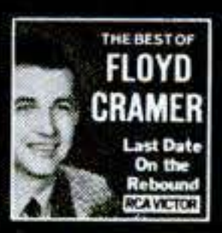

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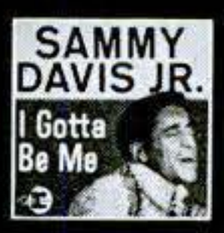

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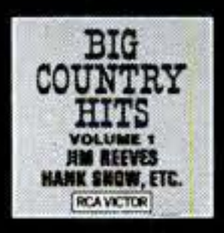

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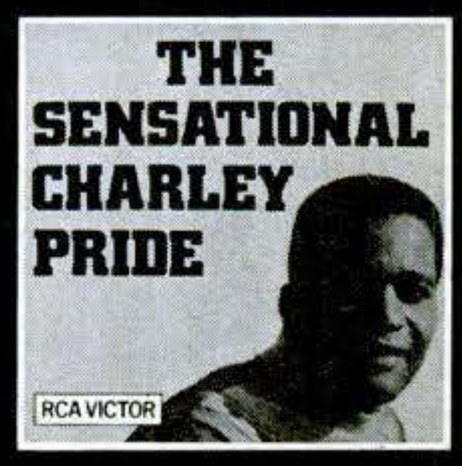

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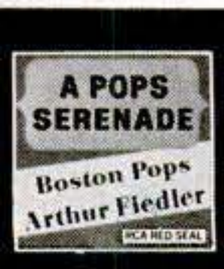

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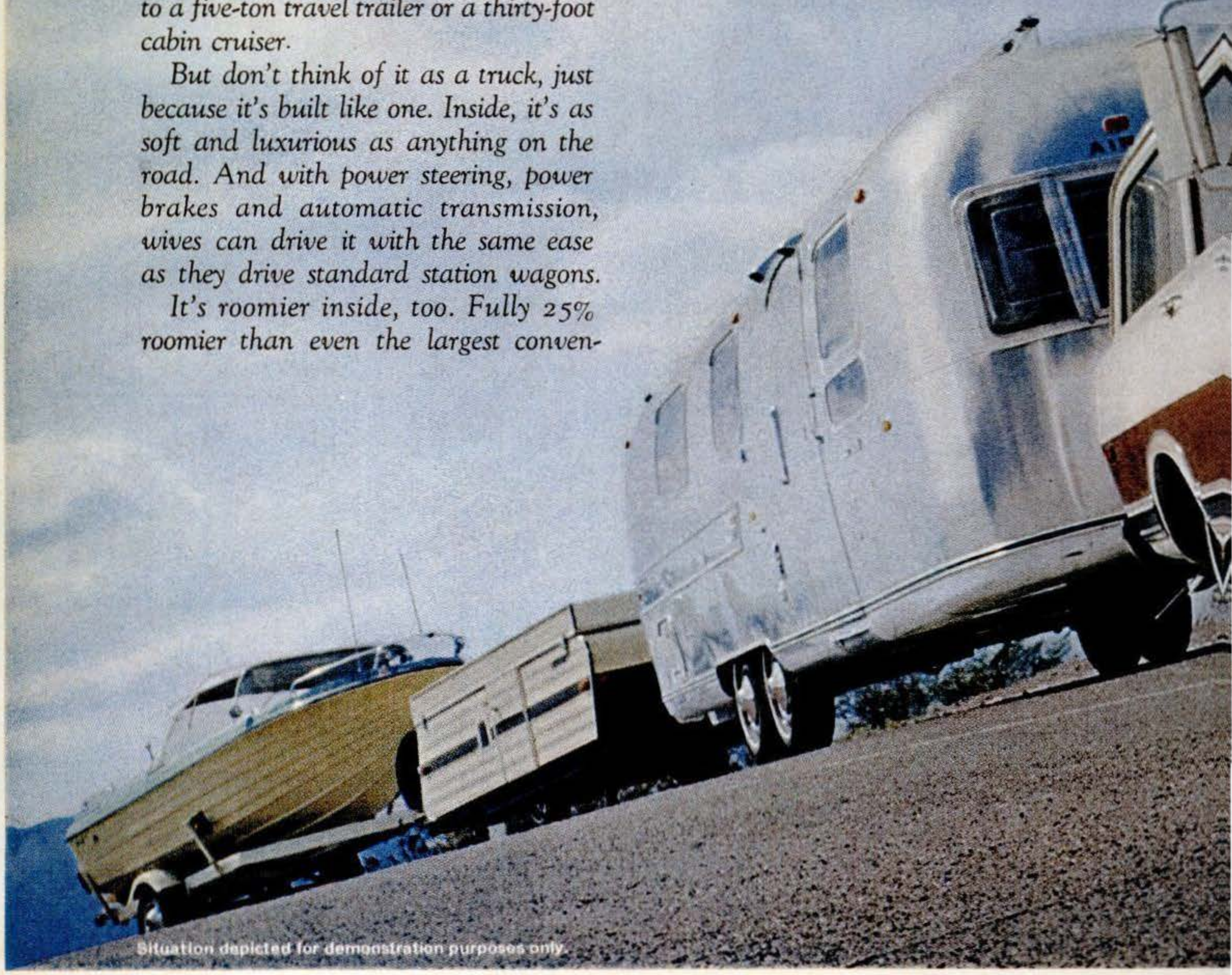

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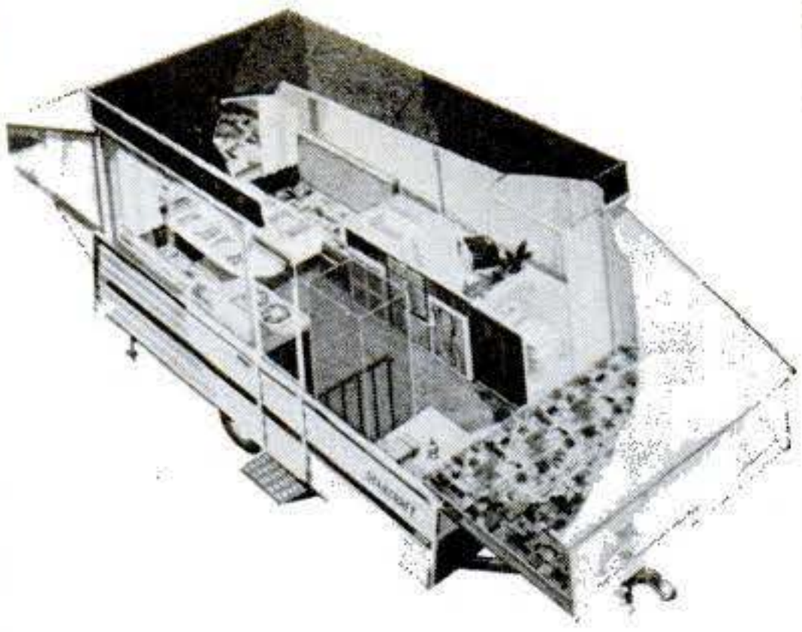


Recreation Roundup

. . . on the move with PS

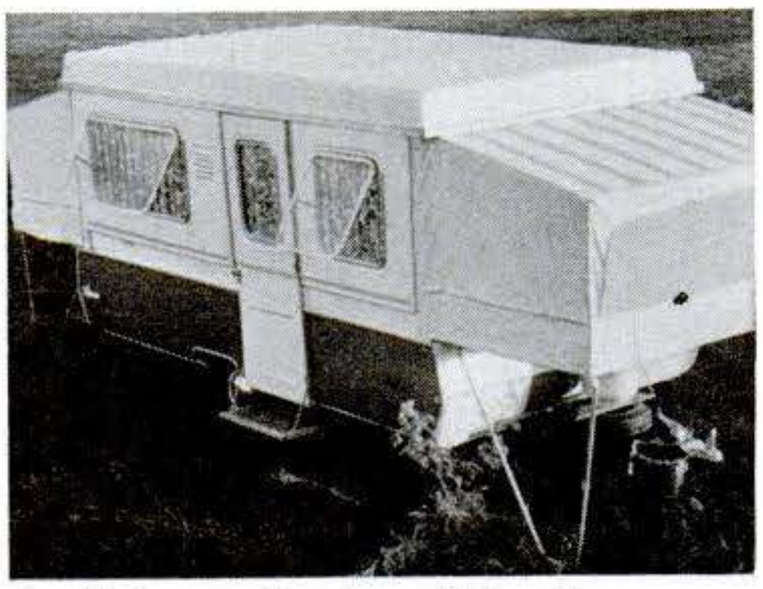
Starcraft's new Executive camper sports a host of luxurious features that make it a cozy family room on wheels. It sleeps six and has a full kitchen and shower-toilet.

By HERBERT SHULDINER

Innovation and variety stood out sharply as I previewed the 1970 crop of camping trailers, pickup campers, travel trailers, and motor homes at the Recreational Vehicle Institute's annual show in the gigantic Kentucky Fair and Exposition Center in Louisville, recently.

As I looked over the more than 1,500 recreational vehicles at the show, I was particularly impressed with dramatic improvements in camping trailers and the explosion in motor homes.

Nimrod Seventy has a fold-out porch.



Apache's new line has solid walls.

One of the most striking departures in camping trailer construction is Apache's new "solid-state" design, in which solid walls of ABS plastic are used instead of canvas. This allows Apache to make its campers with solid, aluminum-framed windows and screens.

The new Apache line is available in two chassis sizes and you can choose from four new interiors. Prices range from $1,095 up.

A new spring-loaded worm gear system is used to provide almost effortless opening and closing of the unit.

The Nimrod Seventy introduces a new built-in spaciousness in the medium-priced camping trailer category. Nimrod gives you this extra space with a novel fold-out rear porch which contains a kitchen, and even an optional double bed. By moving the kitchen to the porch you get a centered dinette and additional walk-through space. The Nimrod Seventy is priced at $1,500.

Starcraft has taken a big step to banish any sign of austerity in its new Executive camper. It's one of the most luxurious rigs ever to be produced. The black-vinyl-hardtopped camper offers a three-burner range, gas-electric refrigerator, one-piece molded-fiberglass shower stall and a toilet with holding tank as standard equipment.

All this is housed in a decorator interior which makes you feel you have taken your family room out to the woods.

[*Continued to page 147*]

Coleman CT 490 has redesigned crank system to ease setting-up problems.

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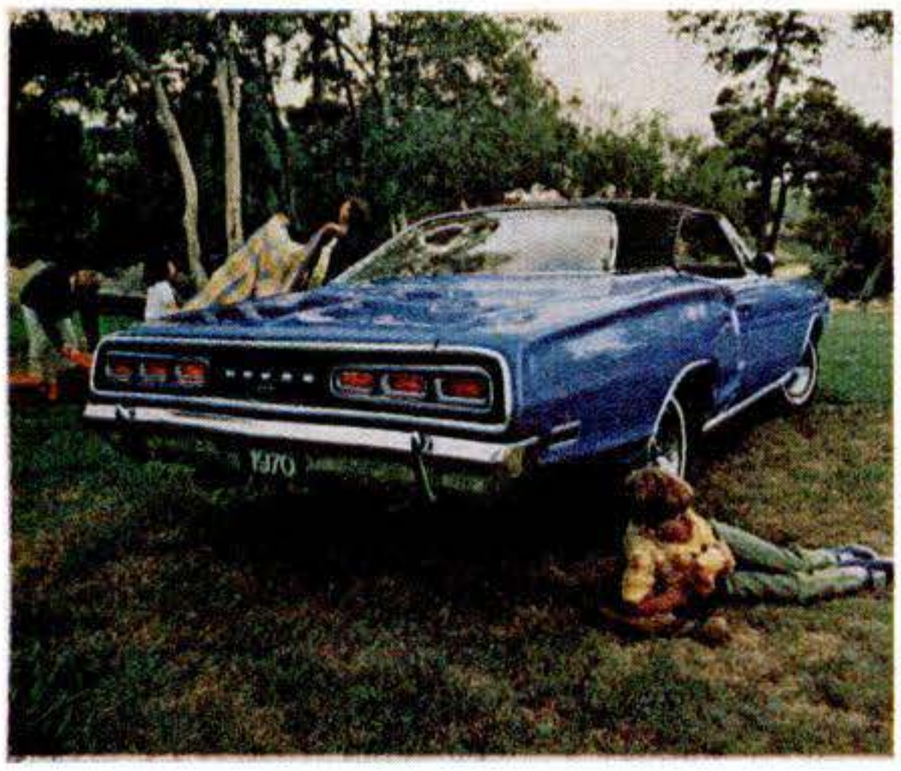

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This month we present an expanded Norbye/Dunne Report. Our test procedure, the most complete we have achieved in over 20 years of car testing, now includes noise-level readings (see box on following page). All tests are made under controlled conditions and recorded with the most modern instruments and equipment available. To the data compiled, we add an in-depth analysis by our two-man team of experts, Jan P. Norbye, PS Automotive Editor, and Jim Dunne, PS Detroit Editor. When you have read and digested this carefully researched consumer-test report, you will be well equipped to make what will be the most important choice of all—your own.

—Ernest V. Heyn, Editor-in-Chief

In the arced line-up, left to right: Buick Riviera, Pontiac Grand Prix, Chevrolet Monte Carlo, Ford Thunderbird, Olds Toronado.

The '70 PERSONAL CARS Combine Luxury and Sportiness

If you're looking for a highway cruiser with superstock power plus the handling of a Trans-Am racer, one of these beauties should fit your needs

By **JAN P. NORBYE** / *PS Automotive Editor* **and JIM DUNNE** / *PS Detroit Editor*

Prior to testing, tires are inflated to recommended pressure. Tanks are filled, oil and water checked, and all luggage removed.

You know, the moment you see one of these cars, that there's nothing ordinary about it. Detroit often calls them "specialty" cars—they combine many specialties of other popular and desirable cars—Cadillac, Camaro, Continental, Cougar. Yet they add some that are uniquely their own: an ability to carry from four to six over any kind of road at higher speeds than any other type of car, and—beyond that—in greater comfort, with less fuss and noise, and with a maximum of safety.

The package idea is limousine space with sleek and sporty styling. The Toronado does this best, with its six-seater interior and flat floor. Riviera is a close second, using the same Fisher E-body. Our test car had a console between the front seats, but a bench seat for three is available on the Riviera. The T-bird, Grand Prix, and Monte Carlo, are four-seaters.

The concept of the specialty or "personal" car started 12 years ago when Ford put a back seat in the Thunderbird. That took it out of competition with the Corvette, and it had a market segment to itself until '63, when Buick announced the Riviera. The Toronado from Olds followed in '66 and Pontiac came in with its Grand Prix in '69. Now Chevrolet, whose Corvette continues as a successful out-and-out sports car, is challenging the T-bird on its own ground with the new Monte Carlo.

To test these cars, we did hundreds of miles of highway driving, put in several days in city traffic, and ran a series of performance tests at Bridgehampton race circuit. And we added a significant new dimension to our tests this year: noise-level testing.

There are some things the cars have in common. They share the ability to cruise at 125 mph (we proved this

PHOTOS BY ORLANDO GUERRA

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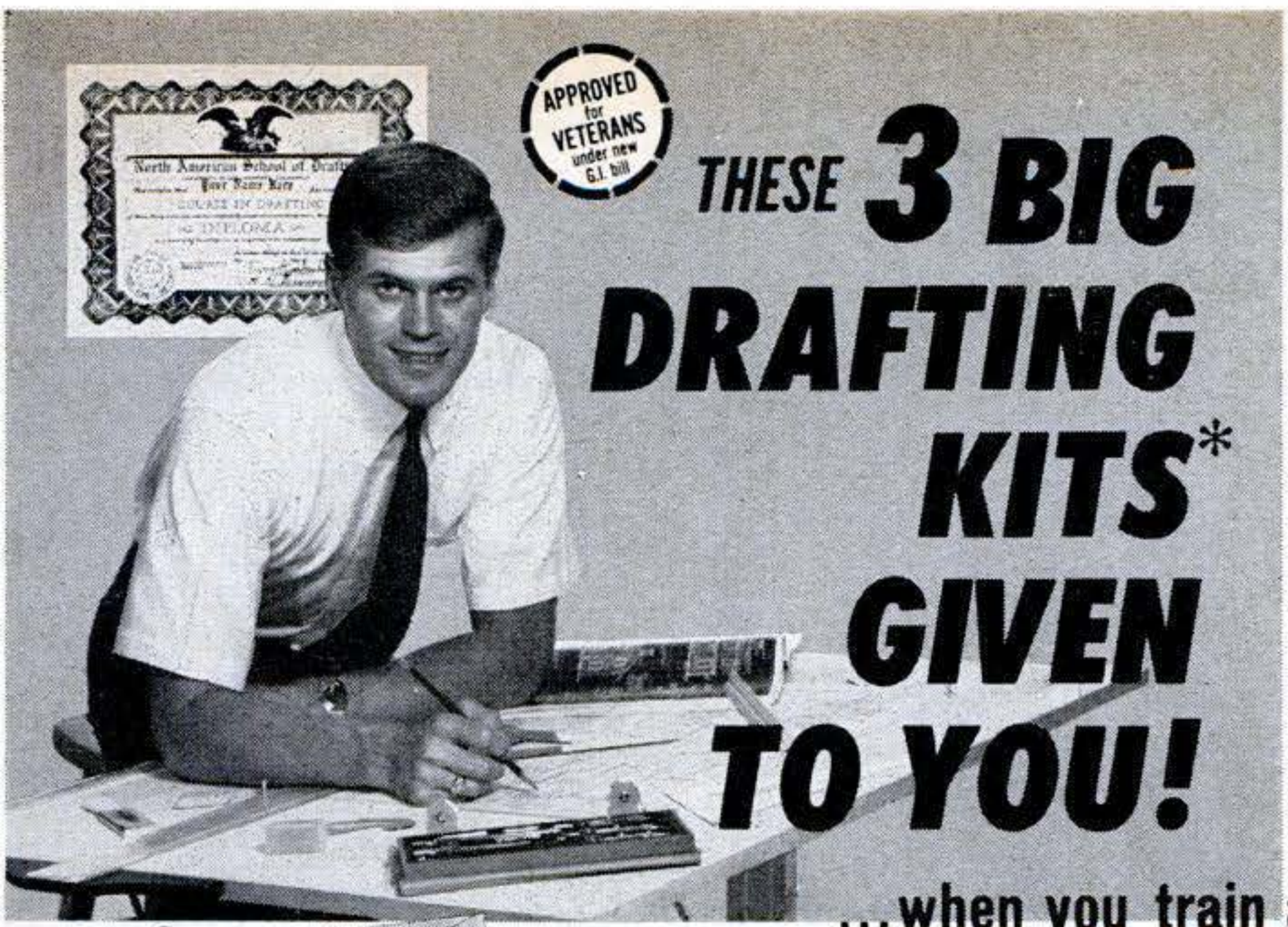

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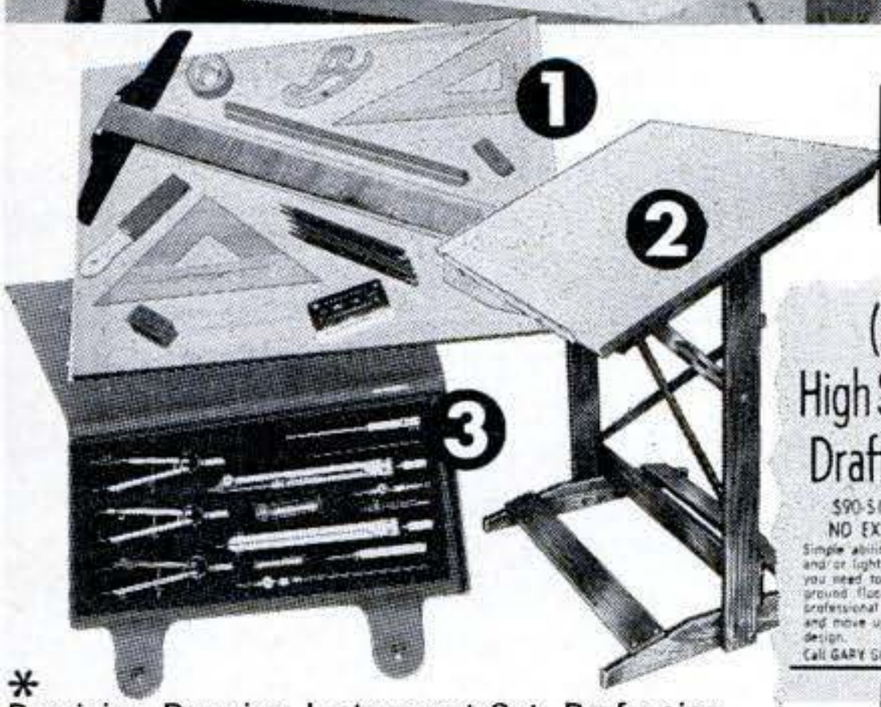

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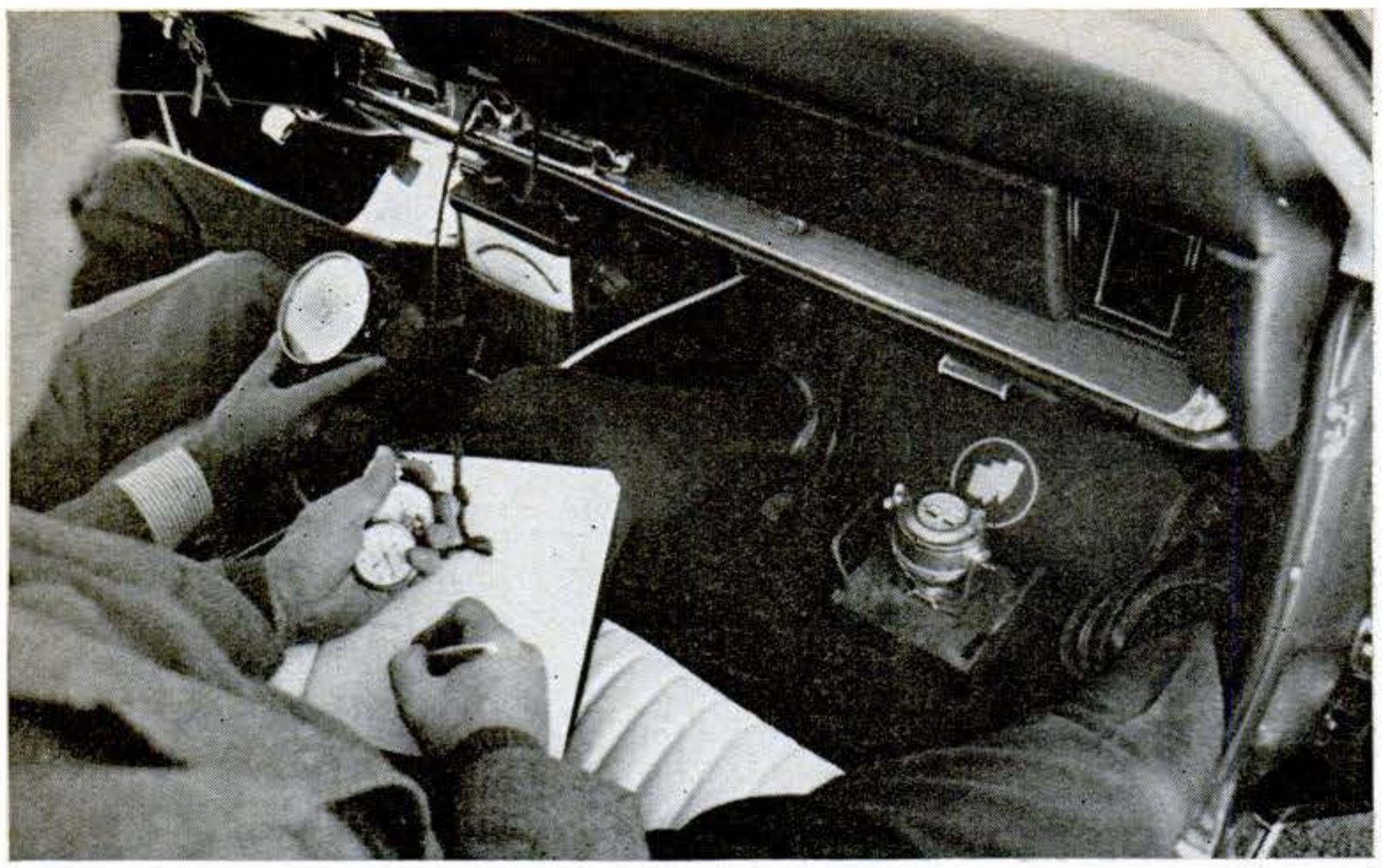


Brake-testing equipment includes Tapley meter to record deceleration rate (on the floor), gauge for pedal pressure (in driver's grasp), and electric speedometer connected to a fifth wheel. Co-driver times stops, on stopwatch, notes results and observations.

out). They have enormous engines and naturally give lousy fuel economy. They all demonstrated complete reliability. We suffered no failures of any kind on them. If you're surprised that we mention that, you should be told that we occasionally find serious defects in test cars, even at this price level. These are great highway cars with high stability. No amount of side wind seems to bother them, and wet weather doesn't slow them down much. On the other hand, their overall dimensions don't make for ease of parking, and they suffer from the inconvenience that plagues all two-door cars with a back seat.

Most of this was expected. But we also found some surprises:

- The amazing versatility of the Grand Prix.
- Terrific improvements in handling on the T-bird.
- Sensational performance from the Riviera's finned aluminum drum brakes.
- An all-new Chevrolet with built-in ability to take everything in stride.
- An inexplicable lack of improvement in Toronado handling and brake performance after all of five years' development.

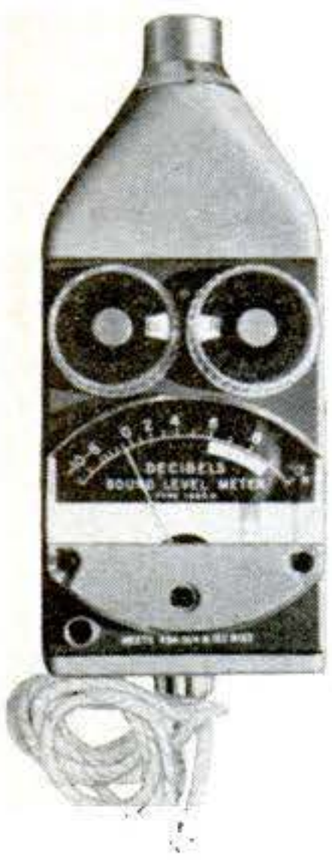
All these cars, as a group, are about 10 decibels quieter than the compacts and sub-compacts tested last month, in each frequency band and under each set of conditions (explained in the box below). The Buick has the least mechanical noise at high speed; Chevy and Olds, the most. The Olds has most wind noise at high speed; T-bird least at all speeds. The Grand Prix has most chassis rumble on smooth roads, regardless of speed. You'll find a full breakdown in the box below.

Now let's look at each car individually:

The Riviera. It impresses with its great handling at all speeds. Its steering response and precision belie its massive size and weight. The car shows great balance and stability, though the springs are relatively soft. Quick variable-ratio steering adds to the joy of driving a Riviera. It almost makes conventional power steering seem obsolete. But the driver will not like the console-mounted transmission lever in the bucket-seat model. The driver's weight pushes the seat down to where it interferes with his ability to operate the button on the end of the handle. He may hit his wrist on the console edge when downshifting to low. And he'll be disappointed that a car at this price—almost $7,000—gives him only a speedometer and fuel gauge; the rest—idiot lights.

Underhood accessibility is good. Not even the air conditioner gets in the way of normal maintenance chores. Plugs, except at right front, are easily reached. Buick is the only car of the five with a sealed cooling system. This offers extra protection against overheating, prevents loss of

How PS tests cars for interior noise levels



Ford's five years of "quiet-car" advertising has made us all concerned about noise in cars. Our General Radio sound-level meter records noise in three frequency bands in decibels. Zero decibels is at about the threshold of hearing; 100 decibels is the noise level in an electric-furnace area. Noise in your home is probably about 50 decibels, unless you're close to a jetport or main road. The 110-decibel level is reached in the casting-shakeout area in a foundry.

Why three frequencies? To avoid comparing types of noise. The highest frequency is denoted *A*, the lowest *C*. The *A* test picks up wind noise, high-pitched rattles and vibrations. The *B* test picks up engine, drive-train, air-cleaner, and exhaust noise, and medium-pitched body vibrations. The *C* frequency test picks up road noise, and all shake and vibration transmitted to the chassis and body from wheels and tires.

We position the instrument in the noisiest place in the car—by the driver's left ear. With all windows closed, and heater, air conditioner, wipers, and radio off, the car is driven on a smooth road at a steady 30 mph, then at 60. Then we measure noise levels at 30 mph on a rough road. In each test, we record the average decibel reading in *A*, *B*, and *C* frequencies. Next, we compare and analyze the noise problems that the sound-level meter has established.

	30 mph smooth road	60 mph smooth road	30 mph rough road
Riviera	59A/72B/86C	68A/78B/91C	68A/87B/98C
Monte Carlo	61A/74B/85C	68A/80B/92C	73A/86B/98C
Thunderbird	58A/71B/85C	67A/79B/91C	71A/86B/97C
Toronado	59A/74B/86C	72A/80B/90C	69A/84B/97C
Grand Prix	60A/73B/87C	68A/79B/94C	72A/84B/98C

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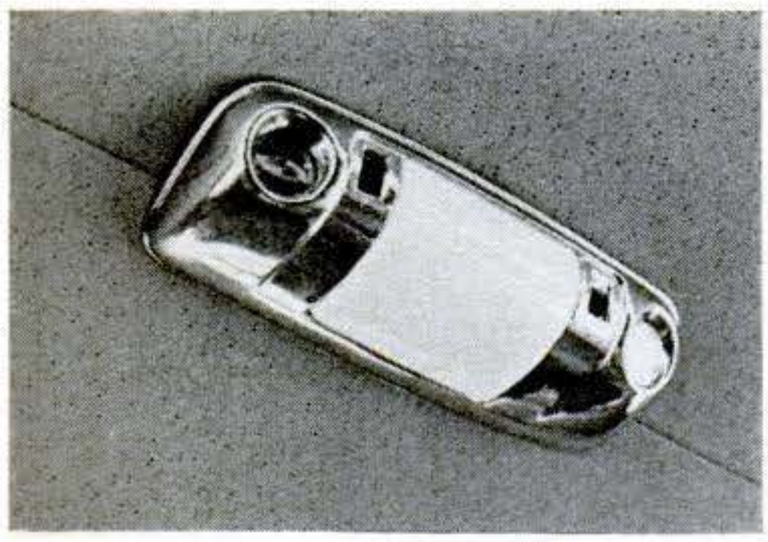
Toronado up front comfortably holds three, due mainly to absence of transmission hump (car has front drive). Back seat, though unpleasantly low, is wide, making car true six-seater. Thunderbird (right) is small four-seater, but this six-foot-two, 307-pounder fits behind wheel. Very wide doors make front entry and exit easy in all cars, except where doors can't be opened wide.

coolant, and can be refilled when hot.

Last but not least: The standard drum brakes are outstanding. The Riviera is the only car in the group with brakes that properly match its speed capacity. It stopped from 60 mph in 140 feet, with normal pedal pressure, without side pull or any threat of rear wheel locking, after 10 warmup stops. This was the high point of a season's testing! It proves that going to disk brakes is not the only answer to the problems of stopping a heavy car; and it proves that the present generation of disk brakes still has considerable improvement potential.



The dome light in Pontiac's Grand Prix is flanked by two pencil-beam lights fixed to point forward. They proved excellent for mapreading, and have individual switches

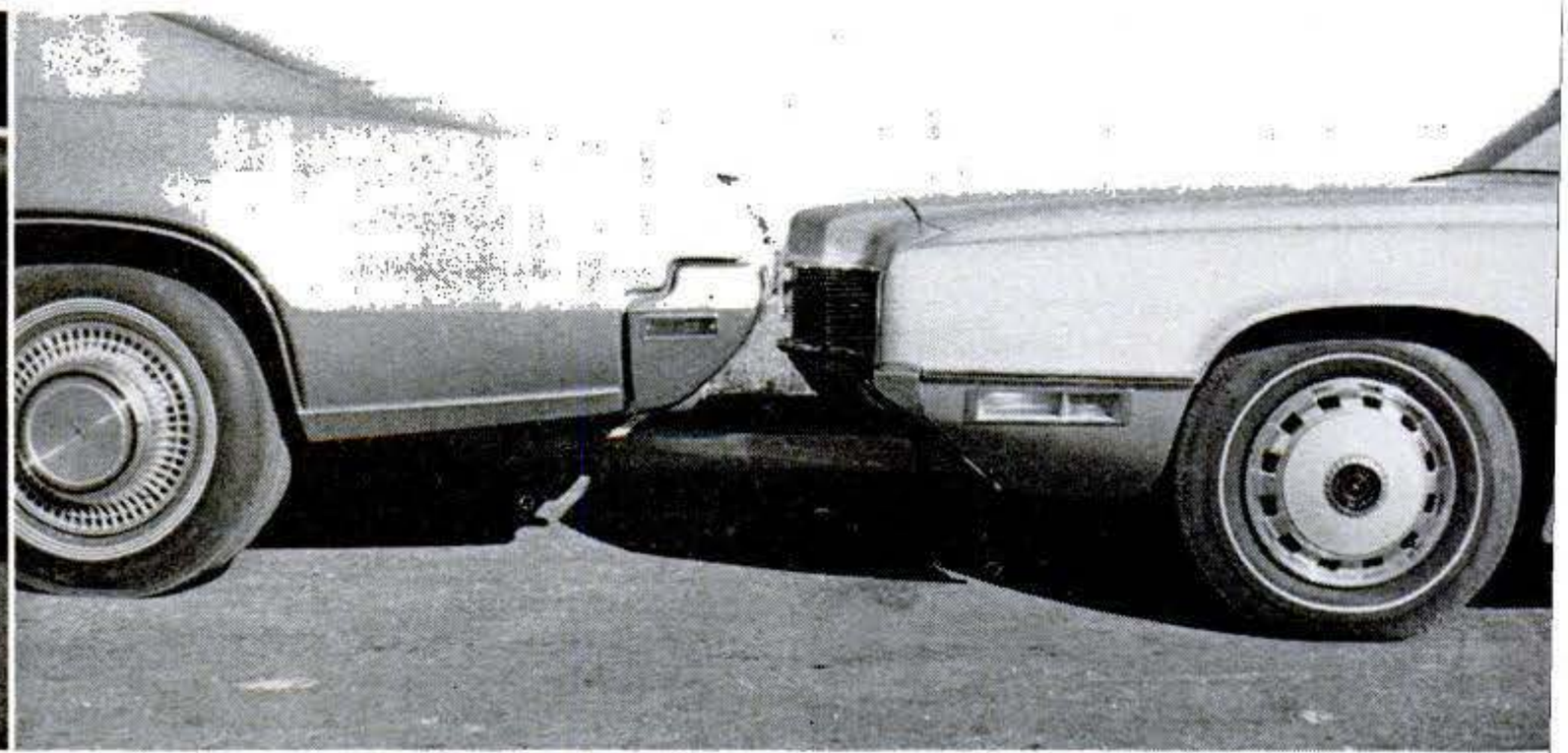
The Monte Carlo. This is the least expensive car in the group, but its styling sets it apart from all other Chevy models. It shares the Fisher G-body with Pontiac's Grand Prix, however. It performed creditably in all tests, yet failed to excite us. It did not accelerate like the Grand Prix; it did not stop like the Riviera. Interior trim (excluding the instrument panel) is taken from the Chevelle and is of lower grade than that on the other four cars. Console, seats, door panels, and armrests are from the low-priced Chevelle. Inside door handles are the old type that could lead to accidental opening of a door by a passenger grabbing for something to hold on to.

Trunk space is good, but the spare wheel is put right where you want to park your luggage. Engine accessibility is restricted by the distributor position—behind the air cleaner; but plugs are not hard to reach. The A/C installation is neat.

The Thunderbird. Exterior dimensions are similar to the other cars, but this one is strictly a four-seater. It does have the richest-looking interior. The optional center console seemed bulky and lacking in purpose. It adds to the feeling of confinement, though the front seats offer good seating even for giants. The instrument panel has gauges for battery charging, temperature, and oil pressure. Bravo! The speed control, in the steering-wheel spokes, is the easiest to operate of all that we have yet tried. The windshield wipers are concealed, but resting on the glass, when still. This design is superior to GM's—which drags the blades across a metal frame.

Seat-back locks that automatically disengage when a door is opened are a good option (though noisy.) Under the hood, plugs (except two right-

Seat-back release lock in Monte Carlo is located in center of backrest, invisible from outside and set to remain locked under forward pressure on the seat back.



Plunging nose on Thunderbird is extremely vulnerable, as witnessed by this typical parallel-parking situation. T-bird bumper offers no protection at all from the massive rear bumper of the Toronado, which is just th right height for smashing in the center o the T-bird grille. Our T-bird was alread equipped with its second grille.

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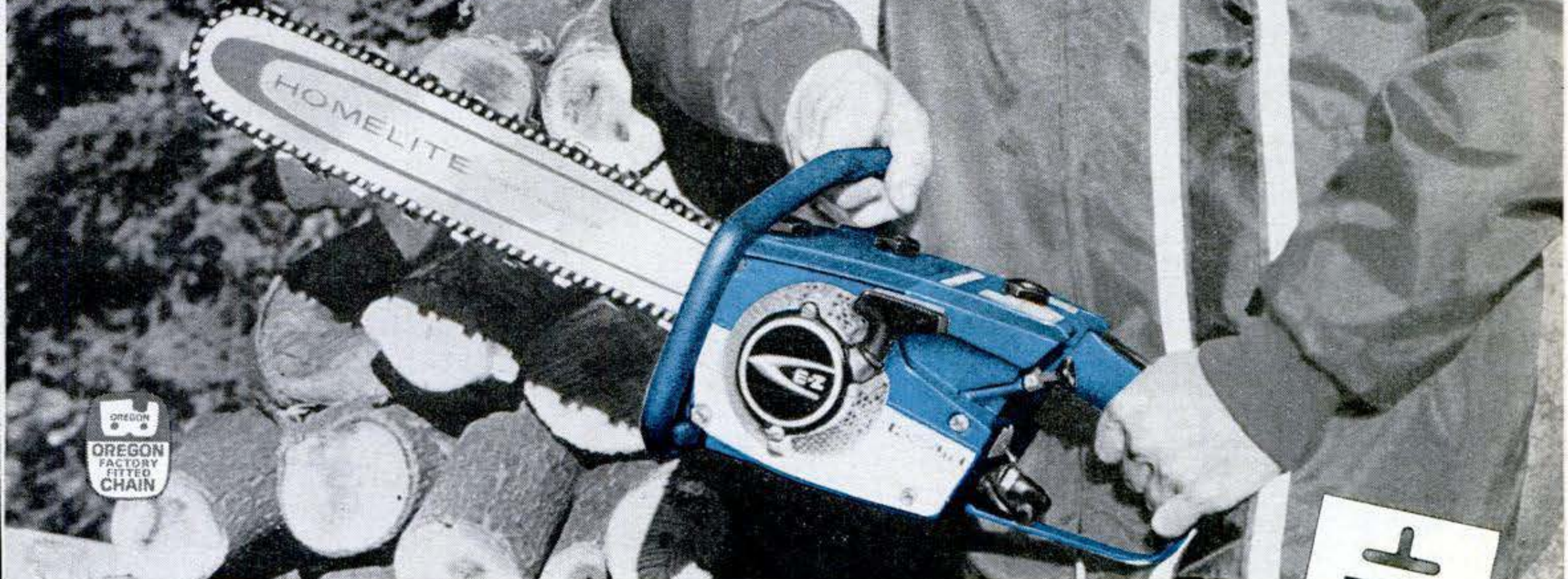

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front ones), distributor, coil, and oil filter are easily reached. A/C installation causes no obstruction. The T-Bird surprised us by running faster through the two lane changes than the far sportier Pontiac. What has Ford done to improve the handling and controllability of this vehicle? First of all, the car has all-rayon radial-ply tires from B.F. Goodrich. They improve both ride and handling. Next the front springs are at least 50 percent stiffer now. The T-bird still understeers, but it doesn't plow as it used to. And the ride is better than that in the GM cars, despite the shorter wheelbase.

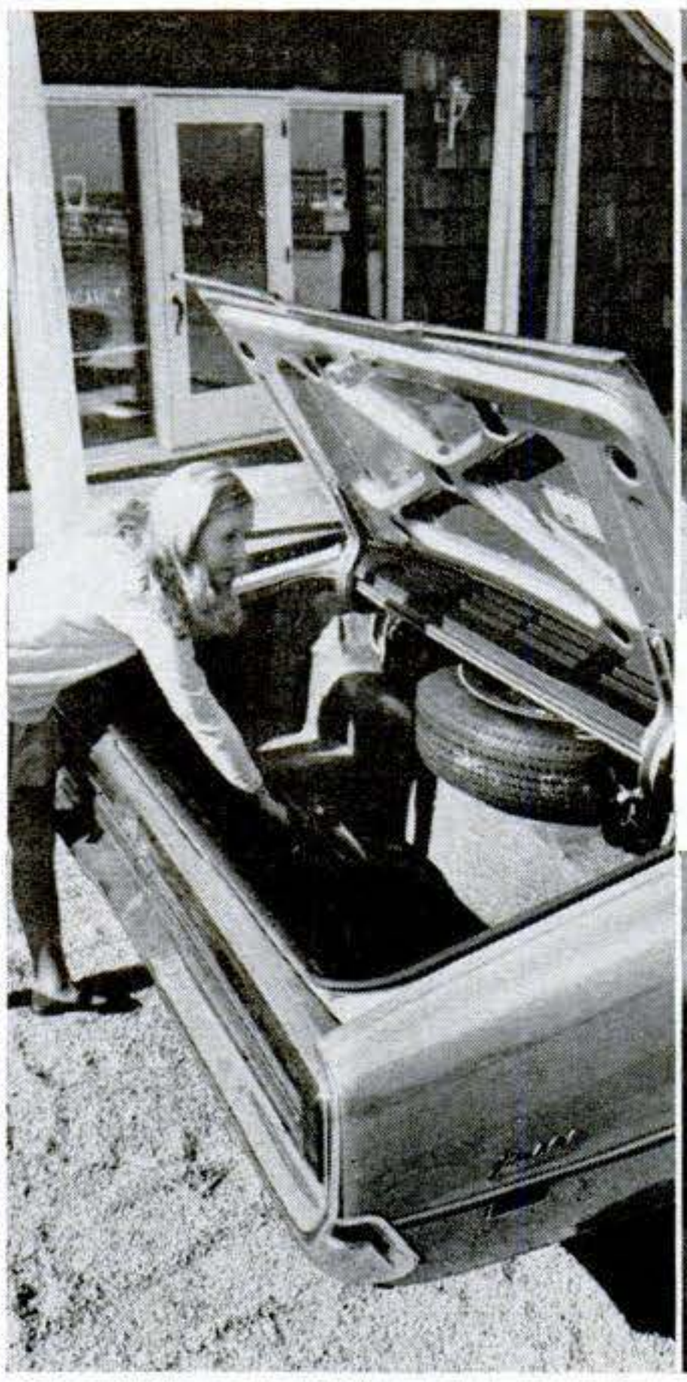
Buick Riviera set new record for cars in its weight class in the brake test—and its surprisingly effective drum brakes proved superior to the disks on the other cars.

Our test car was equipped with the Safe-T-Trak antilocking brake system, and we were sad to find that it failed to work five out of six times.

The Toronado. Here is a marvelous high-speed touring car. Its comfortable ride and straight-as-a-die tracking on straightaways make it a very attractive vehicle for long-distance driving. Its front-wheel drive is also a great asset on wet, icy, or snow covered roads, in loose sand or mud.

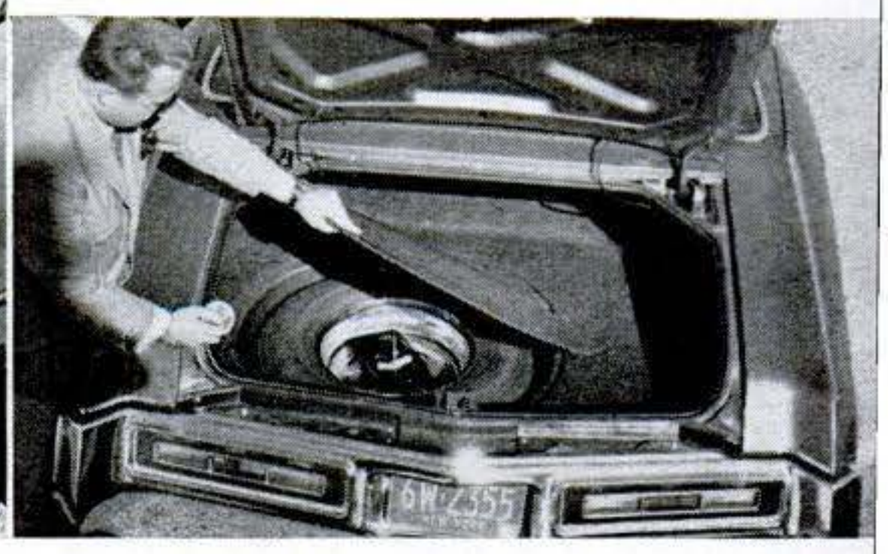
Handling and braking were our biggest disappointments in this car—hard to explain after five years' development. The engine apparently is too heavy for the chassis to benefit from front-wheel drive in terms of cornering. Especially in low-speed maneuvering, the front end showed excessive plowing. The rear wheels locked up in the brake test. Going into a curve braking, rear wheel locking threatened to throw the car out of control.

In contrast with other GM cars the Toronado's heater and vent fan



Thunderbird's trunk has unsuspected depth; trunks and packages store upright. Easily accessible jack and spare wheel steal no useful space.

Toronado's spare wheel is stored against the back seat, in a well, and unless you are Wilt Chamberlain, you'll be going through a circus act every time you have to get it out.



Riviera's trunk is wide but shallow, and its capacity is only 14.7 cubic feet. Spare wheel is conveniently located under a lid in the trunk floor along with jack and other tools.

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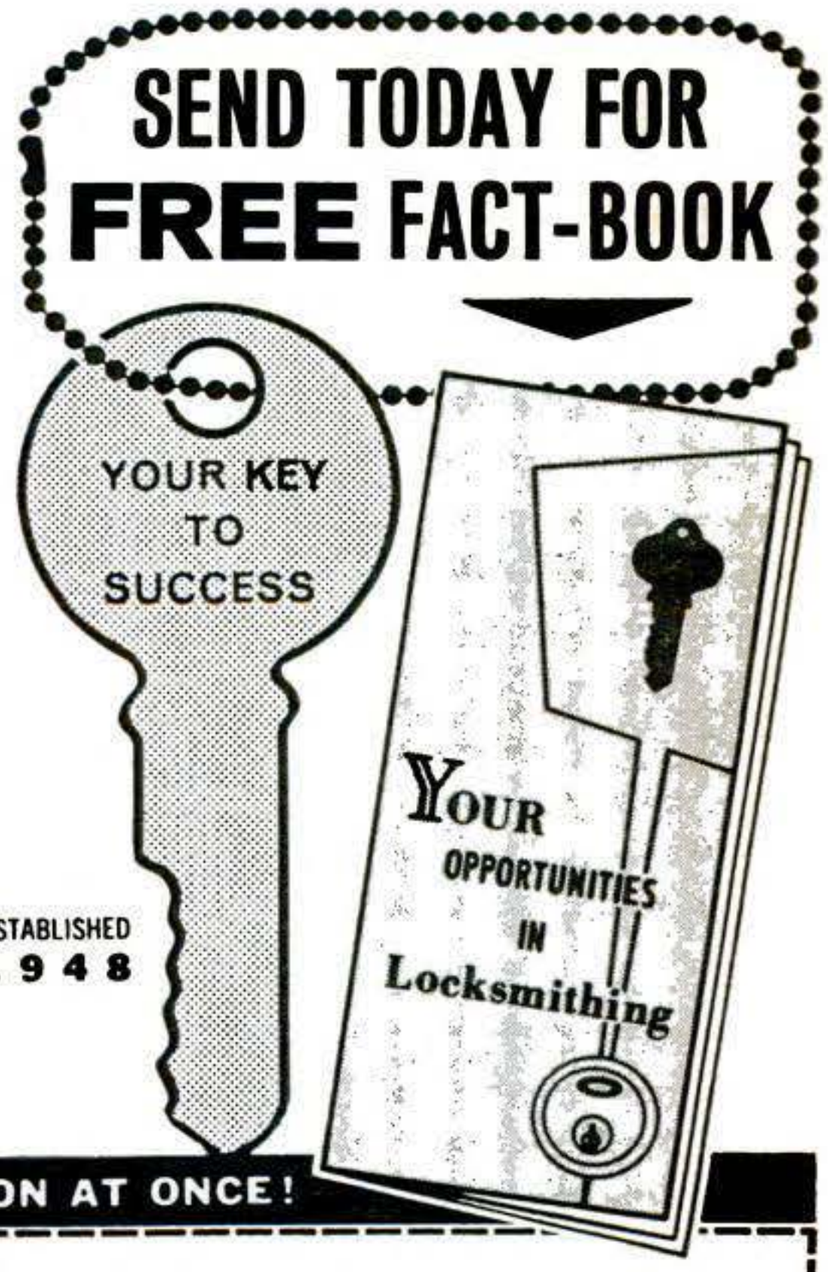

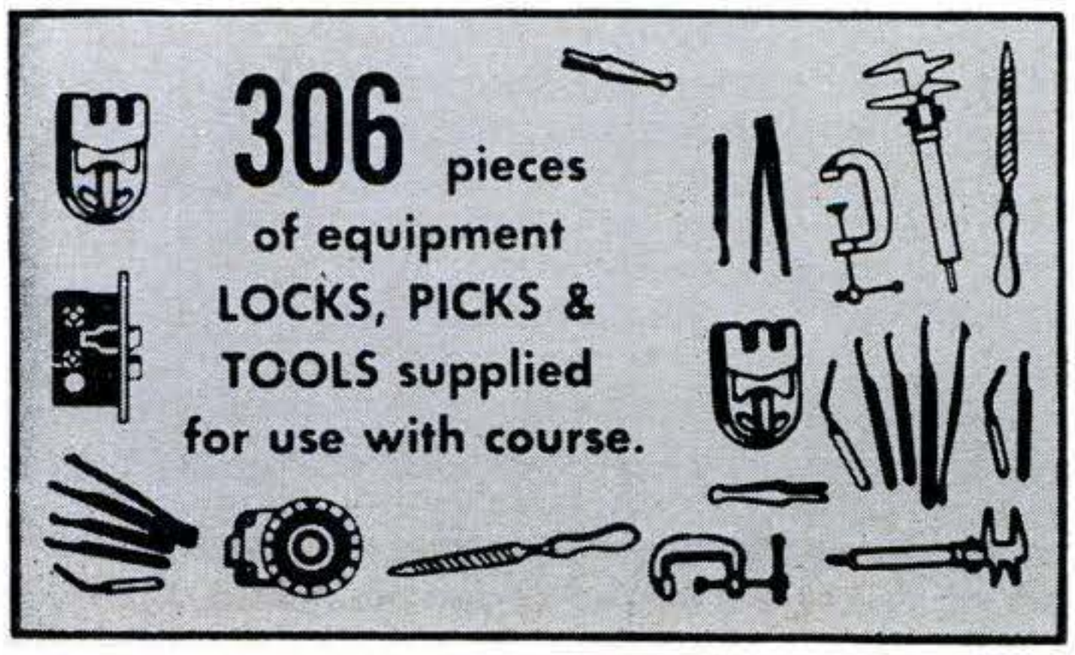

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The '70 Personal Cars

[Continued from page 36]

was remarkably loud, even in low position. The interior finish of the car is impeccable, but it lacks inside door handles for rear-seat riders. The flat floor makes the car a true six-seater (with the split astro-bench seat in front). As in the Riviera, the rear seat is low, but head room is excellent.

Underhood accessibility is poor. The compact drive train makes for a cramped work space, and the A/C pump must be removed before you can change the right-front spark plug.

The Grand Prix. As soon as you get behind the wheel, you know this is a distinctive sporty car, with great handling precision, fast steering, and firm suspension. Above all, it's the driver's car—not the passengers'.

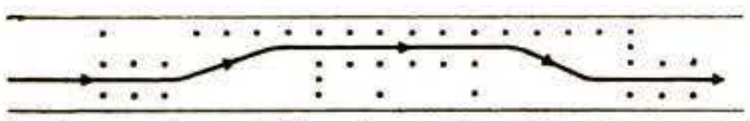
It also proved to have the highest engine performance in the group. The engine is set well back in the chassis, which improves handling response but tends to restrict accessibility. The distributor is smack against the firewall, covered by the speed-control unit, for instance. The brakes might be termed satisfactory on a car with lower speed capacity, but the GP deserves better brakes. It stopped better than most "regular" cars we have tested, but our demands are greater for a car like this.

The Grand Prix is a four-seater. Interior dimensions are almost the same as the Tempest's. Yet the front-seat is high, the interior feels roomy, the long hood is not difficult to judge or position, and the tops of both fenders are well in view. The instrument panel and console sort of envelop the driver, but don't give that closed-in feeling you get in the Thunderbird. Rear-seat room is minimal for legs and head. Instruments are logically placed, easy to read. There are gauges for temp, oil pressure, and fuel; an idiot light only for battery charging.

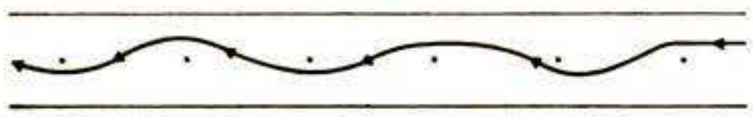
How PS tests cars—and what the tests show

Our brake test shows a car's ability to stop in a straight line from 60 mph, without locking any wheels, after 10 stops from 60 mph at one-minute intervals with ½g deceleration (normal quick stop.) The final stop is made in a 12-foot-wide lane and stopping distance is measured. Excessive pedal pressure indicates fading brakes. Excessive distance indicates fade, locking, or both in combination.

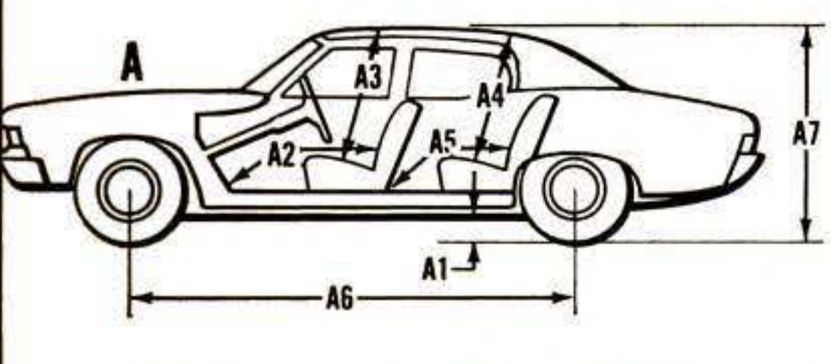
Our 0-60 mph acceleration test shows a car's ability to reach cruising speed from standstill. The 0-80 mph test shows its high-speed power reserve. The 25-70 mph test simulates highway merging situation. Cars with automatic transmission make these tests in **Drive.**

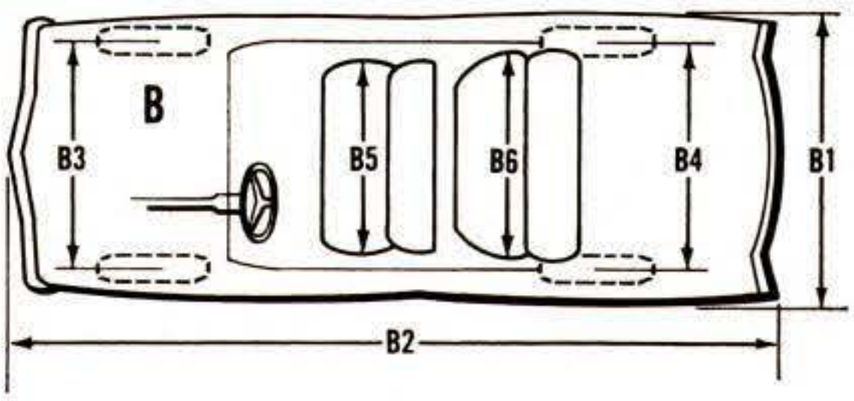


Two lane changes in quick succession show a car's ability to make an emergency maneuver at speed. The lanes are blocked 120 feet apart, and the lane-change gaps are 60 feet long. Each car is put through the test at increasing speed until its maximum has been established.



The low-speed emergency-maneuver test consists of snaking a car as fast as possible through pylons spaced 48 feet apart. In both handling tests, times are clocked by two stopwatches, then converted to mph.





DIMENSIONS (inches)	BUICK Riviera	CHEVROLET Monte Carlo	FORD Thunderbird	OLDSMOBILE Toronado	PONTIAC Grand Prix
A1 Ground clearance	6.86	5.0	5.1	4.5	4.4
A2 Front leg room (max.)	41.2	42.8	42.1	41.3	42.4
A3 Front head room	37.7	37.7	37.1	37.7	37.5
A4 Rear head room	37.5	36.3	36.2	37.2	36.2
A5 Rear leg room (min.)	36.6	32.6	32.0	35.5	31.6
A6 Wheelbase	119.0	116.0	115.0	119.0	118.0
A7 Height	53.6	52.9	51.4	52.8	52.0
B1 Width	79.3	75.6	78.0	78.8	75.7
B2 Length	215.5	205.8	212.5	214.3	210.2
B3 Front track	63.44	59.0	62.0	63.5	62.0
B4 Rear track	63.0	59.0	62.0	63.0	60.0
B5 Front hip room	62.2	59.5	59.2	62.3	57.5
B6 Rear hip room	54.2	58.3	56.8	55.6	52.7
SPECIFICATIONS					
Engine type	OHV V-8	OHV V-8	OHV V-8	OHV V-8	OHV V-8
Bore x stroke (in.)	4.3125x3.90	4.251x4.00	4.36 x 3.59	4.125x4.25	4.15x4.21
Displacement	455 cu. in.	454 cu. in.	429 cu. in.	455 cu. in.	455 cu. in.
Compression ratio	10.0:1	10.25:1	10.5:1	10.25:1	10.25:1
Carburetion	one 4-barrel	one 4-barrel	one 4-barrel	one 4-barrel	one 4-barrel
Power @ rpm	370 @ 4,600	360 @ 5,200	360 @ 4,600	375 @ 4,600	370 @ 4,600
Torque (lbs.-ft.) @ rpm	510 @ 2,800	500 @ 3,600	480 @ 2,800	500 @ 3,000	500 @ 3,100
Transmission	Turbo H-M	Turbo H-M	Cruise-O-M	Turbo H-M	Turbo H-M
Axle ratio	2.78:1	2.73:1	2.75:1	3.07:1	2.93:1
Tires	Firestone	General	B F Goodrich	Firestone	Uniroyal
Tire size	H78-15	G78-15	215R15	L78-15	G78-14
Turning diameter	43.4 ft.	42.2 ft.	42.7 ft.	42.75 ft.	39.3 ft.
Turns, lock to lock	2.9	4.0	4.0	3.4	3.5
Brakes	All drums	Disk/drum	Disk/drum	Disk/drum	Disk/drum
Fuel tank	21 gal.	20 gal.	24.1 gal.	24 gal.	21.5 gal.
Curb weight	4,375 lbs.	3,563 lbs.	4,586 lbs.	4,459 lbs.	3,953 lbs.
TEST RESULTS					
Acceleration 0-60 mph	9.9 sec.	7.85 sec.	10.0 sec.	8.8 sec.	7.3 sec.
Acceleration 0-80 mph	16.3 sec.	12.25 sec.	16.2 sec.	14.0 sec.	11.95 sec.
Acceleration 25-70 mph	10.15 sec.	6.75 sec.	10.0 sec.	9.5 sec.	7.9 sec.
Braking distance 60-0 mph	140 ft. 2 in.	156 ft. 2 in.	207 ft. 8 in.	193 ft. 0 in.	167 ft. 3 in.
Brake-pedal pressure	50 lbs.	200+ lbs.	160 lbs.	200+ lbs.	200+ lbs.
Max speed—lane change	51.0 mph	51.0 mph	54.7 mph	51.0 mph	53.9 mph
Max speed—traffic weave	21.7 mph	21.1 mph	21.1 mph	22.0 mph	24.8 mph
Average fuel mileage	11.0 mpg	9.7 mpg	6.9 mpg	9.4 mpg	11.8 mpg
Price (basic)	$4,854	$3,123	$4,961	$5,023	$3,985
Price (as tested)	$6,782	$5,051	$5,472	$5,846	$5,055

T-Bird with anti-lock on rear wheels suffered from locking of the right rear. System worked once in series of six stops.

Riviera leans hard when making high-speed lane changes, but the car remained under full control, stable and well-balanced.

Monte Carlo proved in its element at the Bridgehampton race circuit—this is an easy car to drive fast and well. Here, you see it taking a long curve at 85 mph.

CONCLUSIONS

Norbye: The Grand Prix is my choice. I feel at ease at the wheel, and love the way it handles. It's surprisingly easy on gasoline in view of its terrific acceleration, and the brakes are adequate for driving at legal speeds.

Dunne: I agree on the Pontiac. It's not long ago that steering like that was unavailable at any price; now that we can get it, that's what I want. This car does everything right, never gets caught unaware. If the suspension is firm, the ride is certainly more acceptable than in a sporty compact. PS

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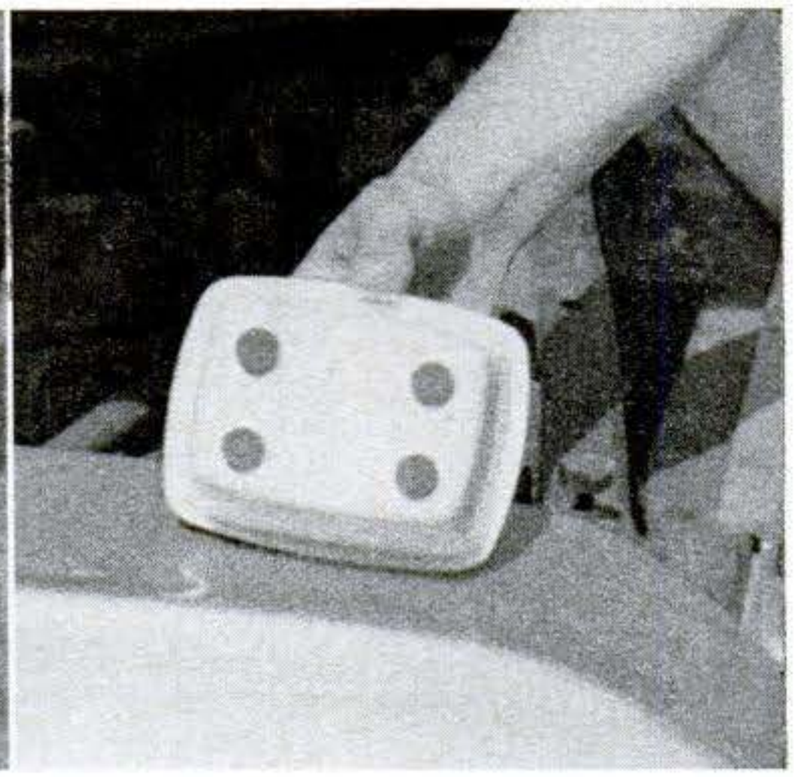
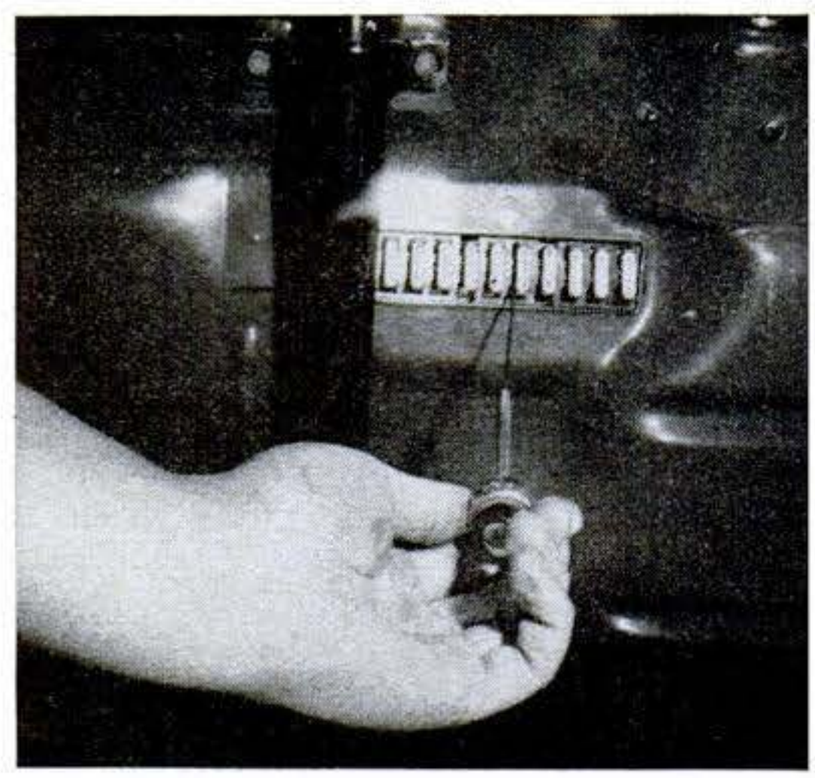
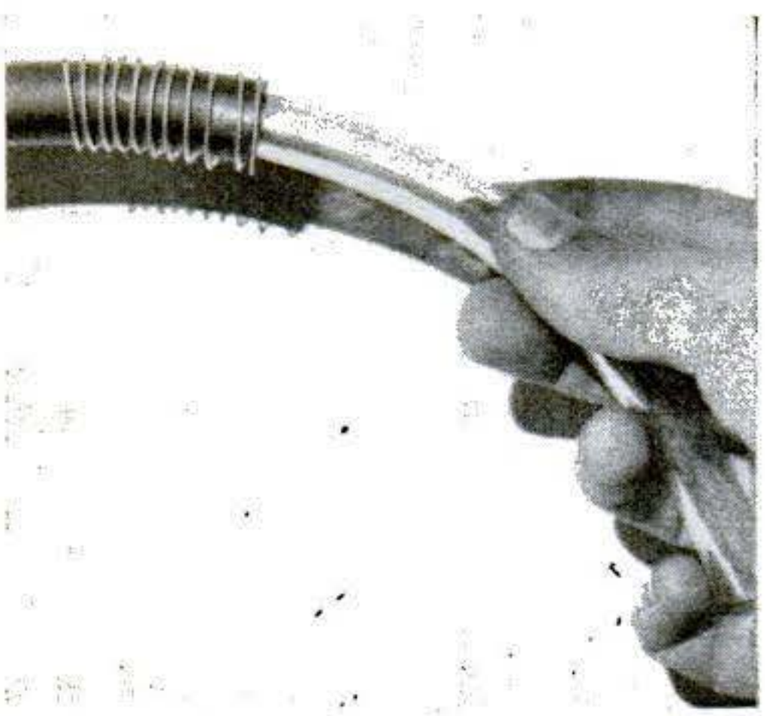
TAKING CARE OF YOUR CAR



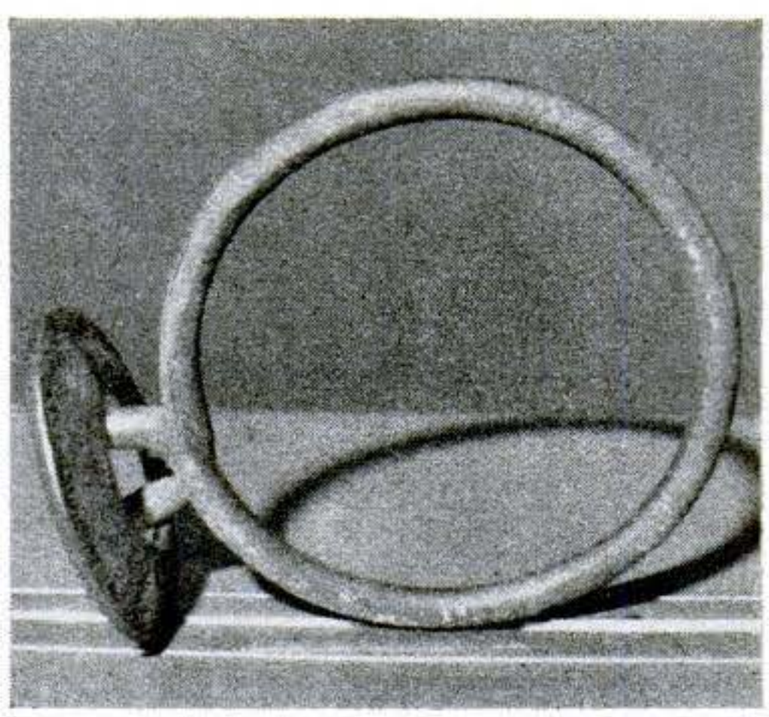
A plastic margarine dish with magnets glued to the bottom is handy around your car. Put those small nuts, bolts, and washers in the dish when you remove the old set of points from your distributor. Then they won't end up lost under your car when you're ready to install the new points. The magnets will keep the dish from sliding off the car; but they can scratch a glossy finish, so cover them with tape or a layer of thin cloth. Turnpike travelers will find one of these dishes on the dash ideal for holding toll money. You can use them without the magnets for no-spill storage containers, too —just ask your wife to save the lids. Label with felt marking pen to indicate contents.



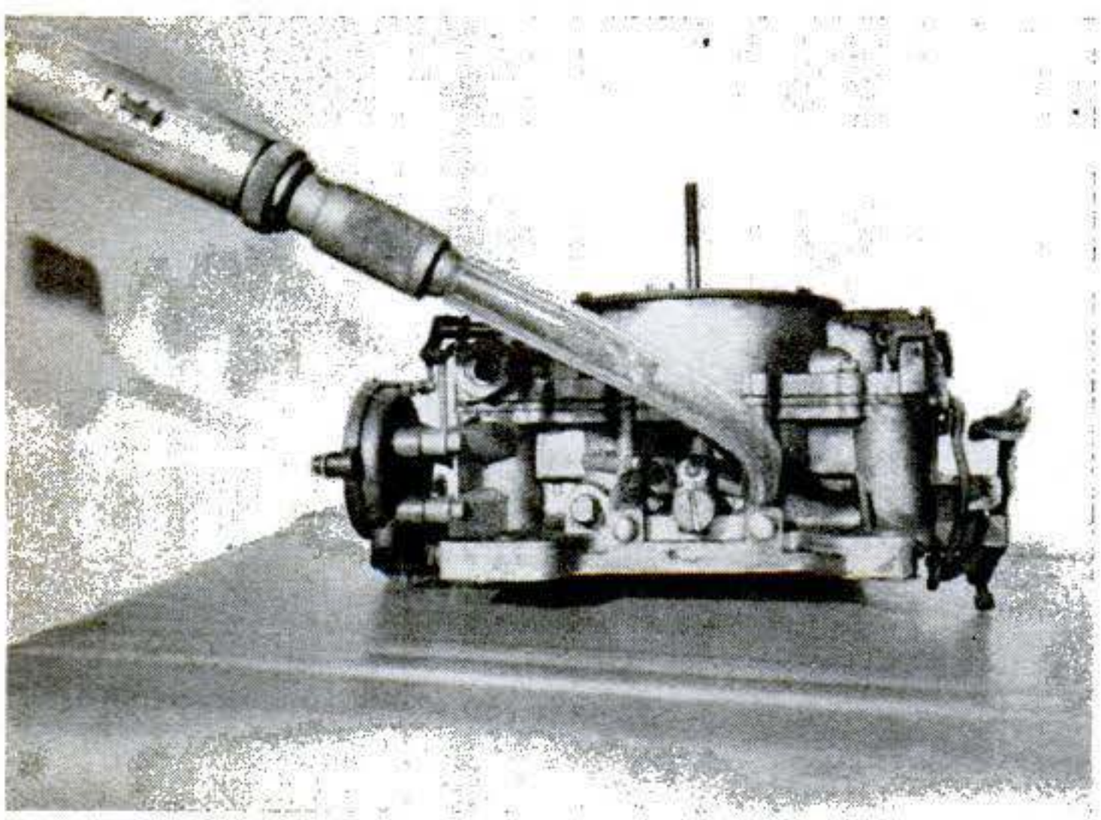
Remove burned-out automobile fuses easily with a puller made from an old choke knob and center wire. Cut the wire six or eight inches long and bend a hook in the end. The puller will reach where your fingers or pliers can't, and won't pulverize the fuses as often happens when you pry them out with any handy screwdriver.



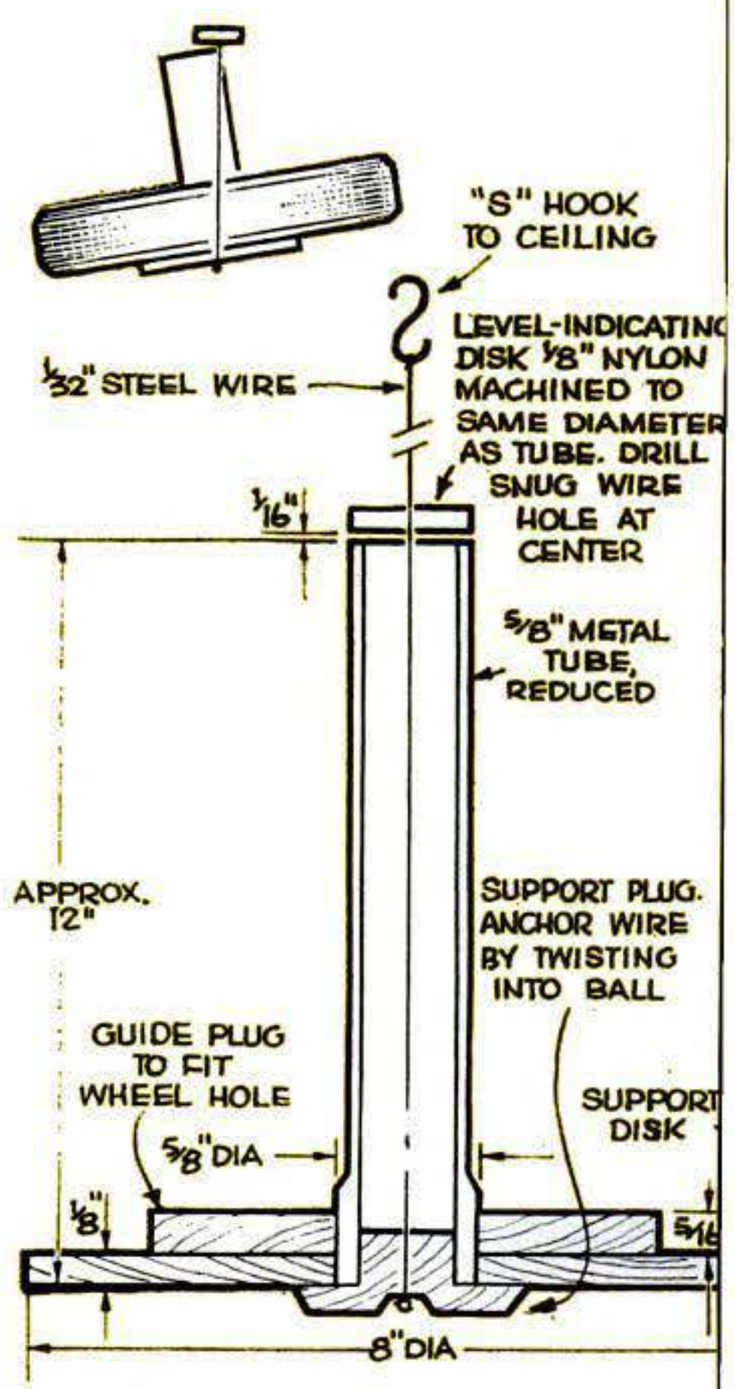
A vacuum hose won't split when forced over metal tubing if you use this simple trick: Prior to installing the hose, slip a small spring over the hose end. The resulting tight, split-free connection will prevent the rough running and loss of power that often occur when automotive vacuum lines leak at connection points.



Heater-hose clamps of the spring type can be a problem to install if you don't have the special notched pliers designed for the job. Try forcing the clamp ears together with your regular pair of pliers. Then slip a washer over the ears to hold the clamp open. When you have the clamp in place, simply remove the washer.



A plastic U-joint made from neoprene hose can help you set the idle on your hard-to-reach carb. Slip one end of a length of hose over the end of a screwdriver, the other end over the knurled head of the idle screw. Now you can turn the screw easily—engine vibrations won't loosen your grip, and the U-joint action of the hose allows you to work with your hands safely away from the engine's searing heat.



Balance wheels at home with this simple device. It consists of a length of steel wire passing through a section of tubing, anchored to a support plug. Fastened to the wire at the top of the tube is a disk of the same diameter as the tube. Balance the wheel until the disk and the top of the tubing are aligned in perfect register.

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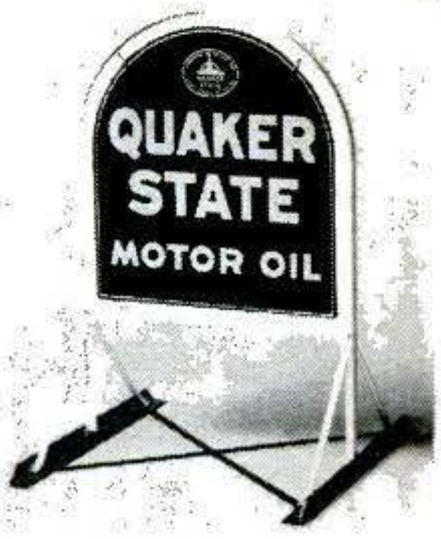

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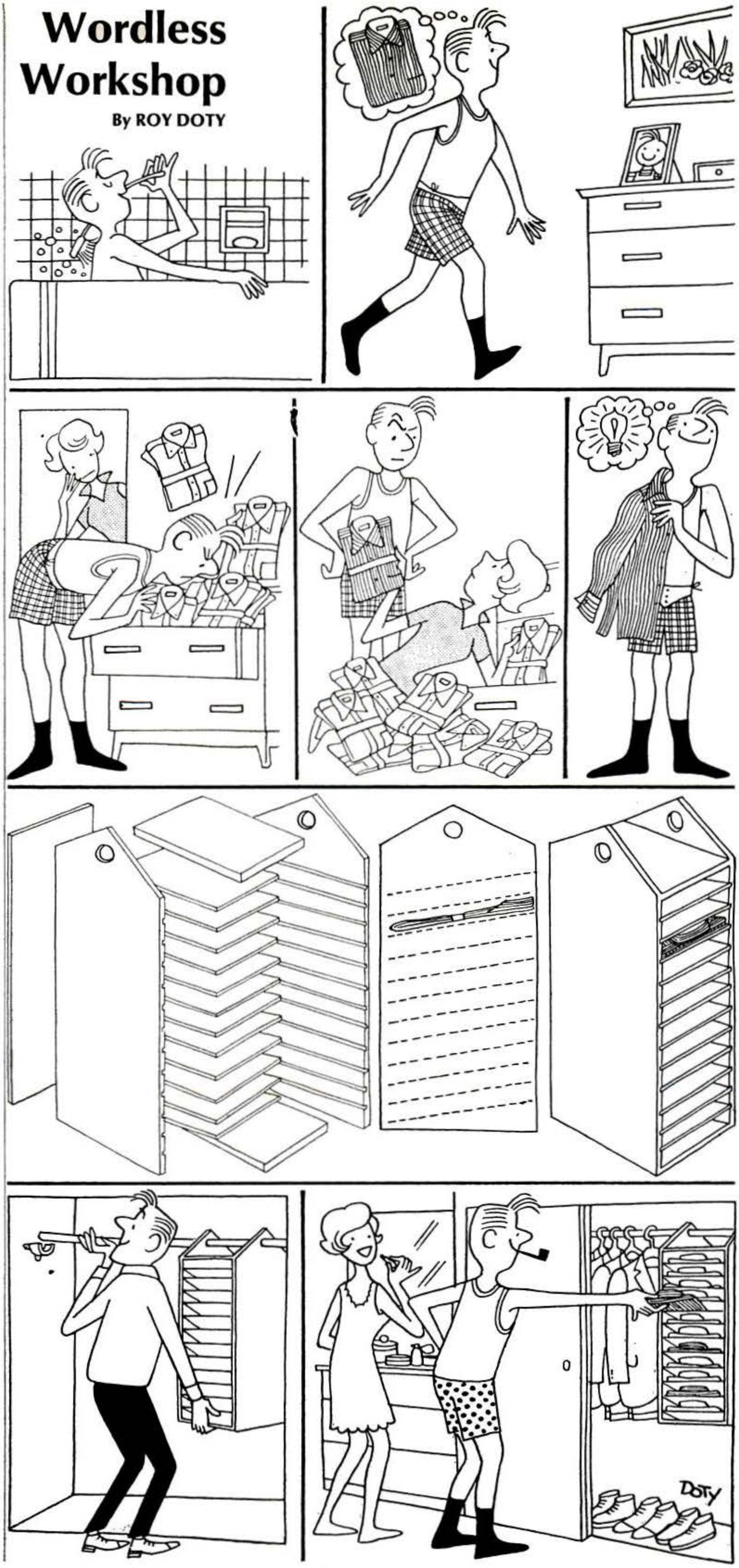

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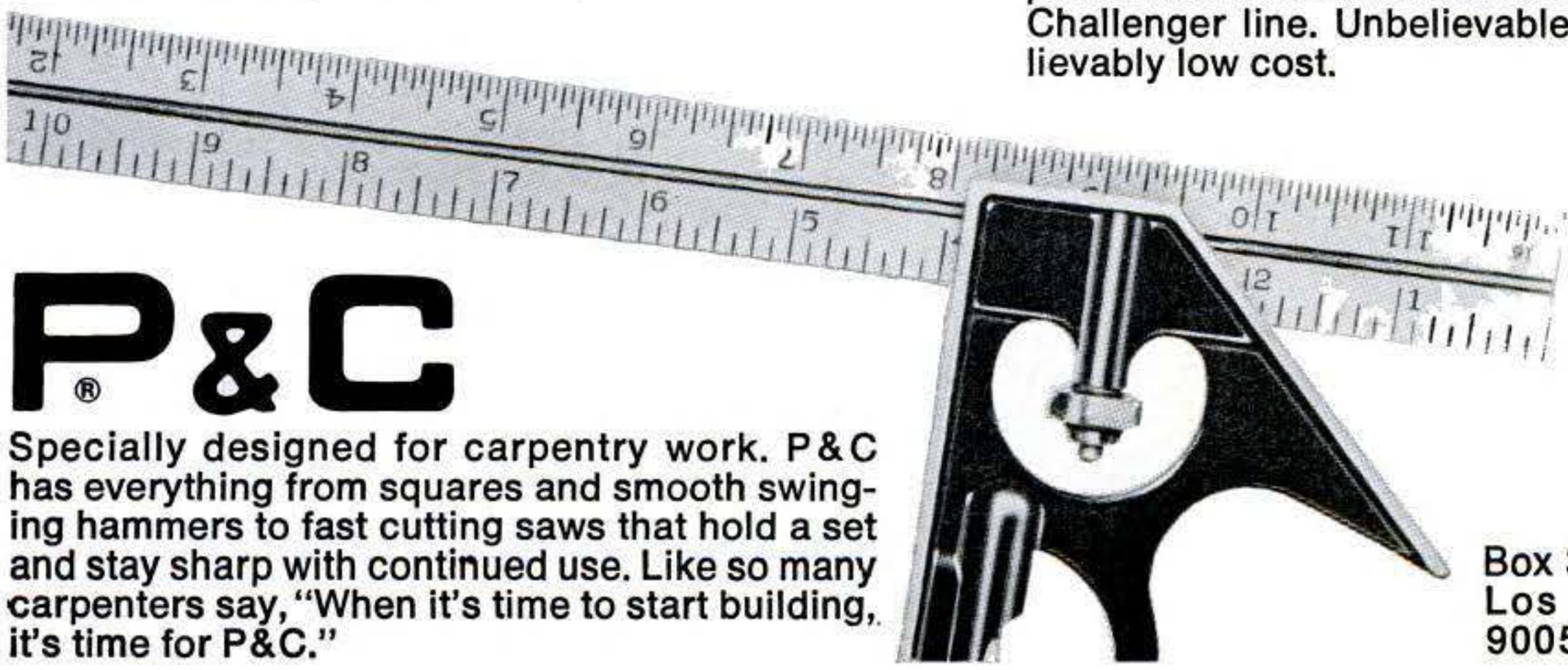

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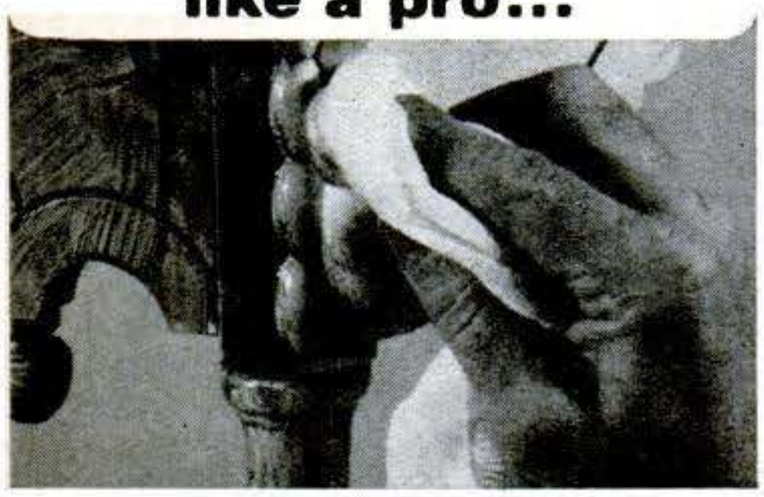

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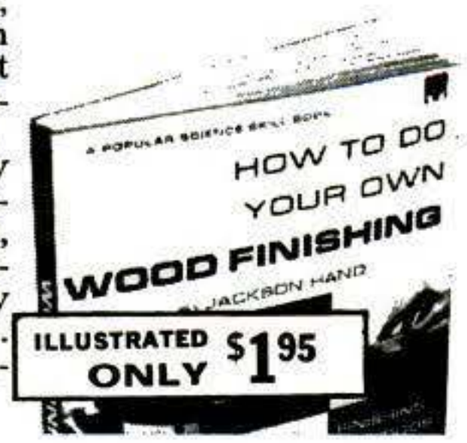

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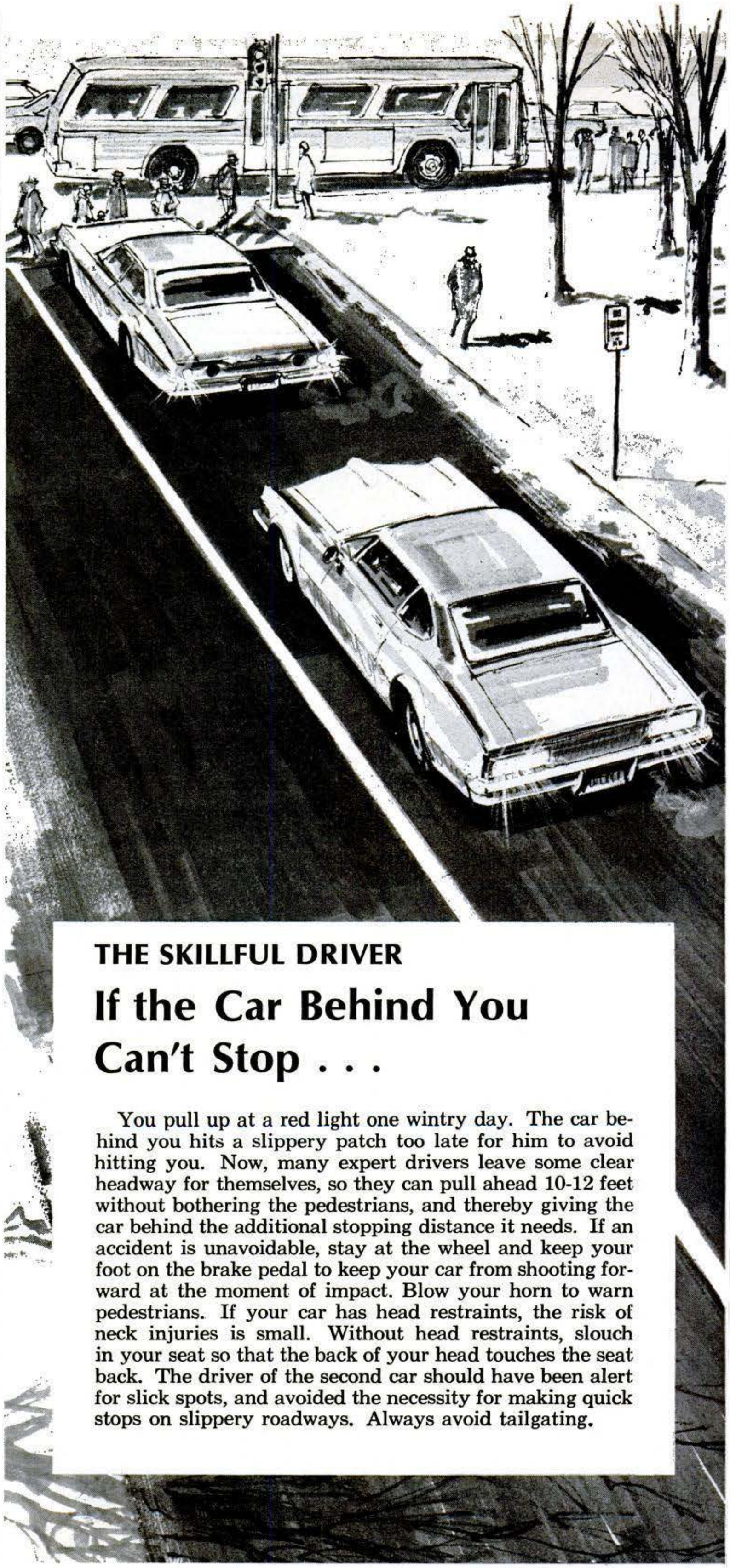

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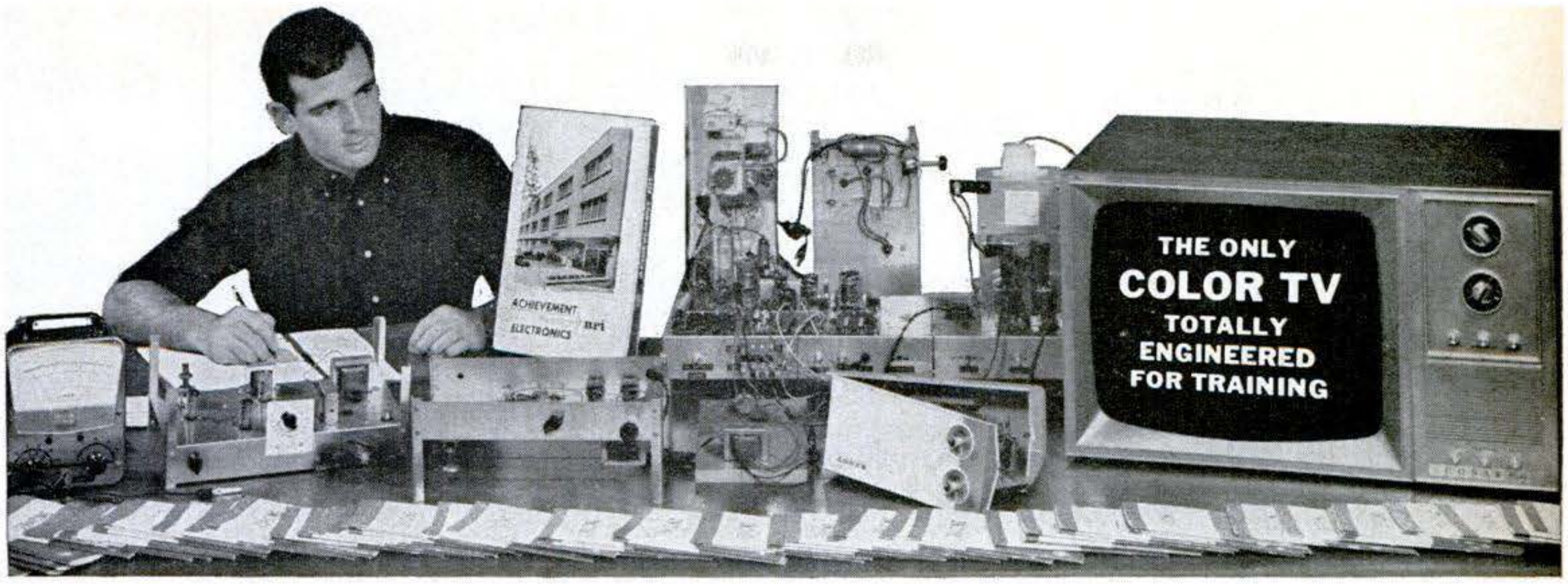

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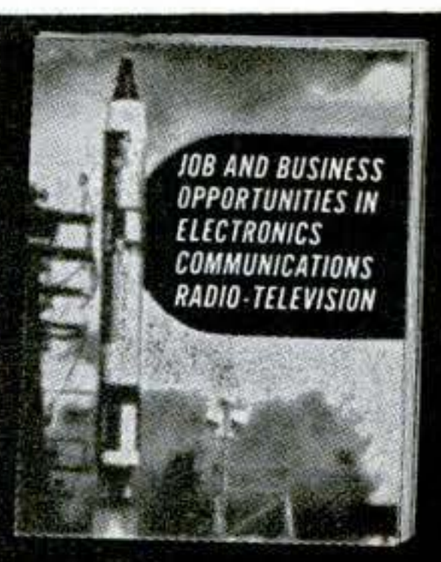

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Science Newsfront

Last-minute news and notes to keep you up-to-date

By ARTHUR FISHER

The Wankel engine flies for the first time in the Lockheed Q-Star, a supremely quiet acoustic-research craft adapted from a Schweizer sailplane. The rotary engine turns a six-bladed wooden propeller via a shaft passing over the top of the cockpit.

Add a new member to carbon's family. Those unlikely twins, graphite and diamond, have been joined by the amazing material you see here—glassy carbon. It was developed by scientists of the Lockheed Missiles & Space Co. for possible use in space, notably as a liner for rocket nozzles. There, the new material will

withstand crunching pressures, searing heat, and the scathing corrosion of exotic rocket fuels containing fluorine. Extremely hard, glassy carbon resembles glass in shine, resistance to chemical attack, and a random atomic structure that helps account for its properties. Graphite, by contrast, has an ordered structure that tends to slip along certain planes when under stress, making it soft and slippery.

The world's first lightning alarm device has been invented by a Swedish company, Nitro Nobel AB. Warning bells and lights go off five minutes ahead of approaching lightning strikes. The device works by measuring both the electrostatic field in its vicinity and the radio pulses emitted by distant electrical storms. It should find grateful use wherever men are working in lightning-prone places, such as power pylons, blasting sites, and, of course, explosives plants like Nitro Nobel.

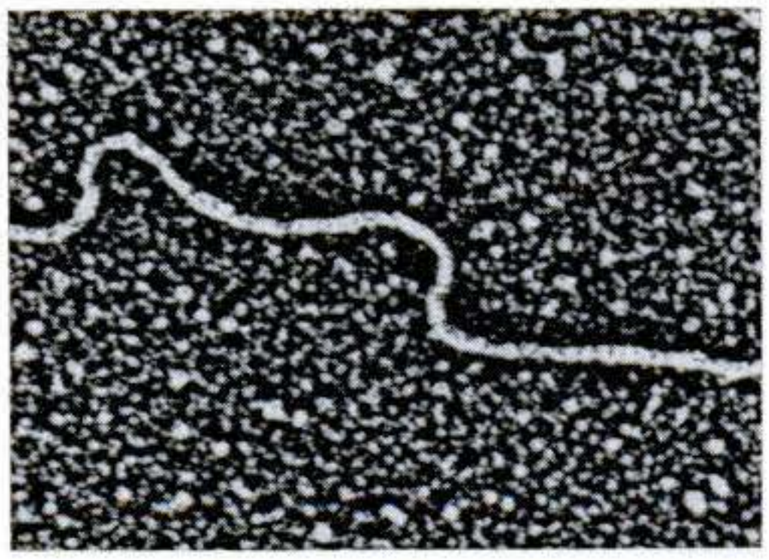
The world's largest telemetering network for early flood warning—to serve five New England states—is ready for action. Built by Motorola, Inc., it combines remote reporting, relay, and repeater stations in five major river basins. Sensors feed data on water levels, precipitation, tides, wind, and barometric pressure to a Reservoir Control Center. In seconds, engineers at the center can be alerted to imminent danger and forestall it by operating any of 33 flood control dams in the area.

Moon rocks were on the Earth long before Apollo 11 and 12 brought back their famous samples. Ten years of patient scientific detection by Dr. Dean R. Chapman of NASA's Ames Research Center has proved that this planet's 10 to 100 million tons of mysterious fused-glass fragments called tektites originated on the moon. Using a computer, Dr. Chapman determined that the last great tektite shower occurred 700,000 years ago. It sprayed an S-shaped swath of Australia, the Philippines, and Southeast Asia with millions of tons of material spewed from the moon when a mountain-sized meteorite impacted the lunar surface and created the huge crater Tycho, 56 miles across and nine miles deep. Accompanied by billions of brilliant light flashes and the unceasing rumble of sonic booms, the spectacle was probably witnessed by our ancestor, Java man.

3-D movies viewable without glasses will result from a new projection method invented by Dr. Dennis Gabor of CBS Laboratories. Dr. Gabor is the discoverer of holography—three-dimensional lensless photography. His technique uses laser holography to project 3-D movies in color or black and white onto a curved viewing screen that is photosensitive. Two projectors separate the picture into right- and left-eye images, which are reflected in separate vertical zones. The viewer instinctively looks at that part of the screen that will bring him a perfect stereoscopic effect.

Fight tooth decay with plastic paint? No, we haven't garbled two TV commercials. The National Institute of Dental Health will test a new plastic resin material that should protect the biting and grinding surfaces of teeth better than fluorides. A dentist will simply paint the stuff on like nail polish, then shine a gun-shaped ultraviolet lamp on the treated teeth. Long-wave UV makes the resin set instantly, and the plastic liquid hardens into a tough, colorless, near-invisible film over tooth enamel.

A single gene has been isolated from an organism for the first time. Scientists at Harvard Medical School extracted a gene—which is the basic chemical unit of heredity—from a microorganism commonly found in the human intestine. The gene, pictured here, is only 0.000055 inch long.



This feat of legerdemain is another in a long series of successes by molecular biologists working to unravel the secrets of the cell. It points the way toward eventual control over our own heredity, including the elimination of many inherited diseases.

Mining gold with mold may seem to be in the little-green-men category, but Russian scientists at the Irkutsk Institute of Rare Metals are taking the idea seriously. One champion fungus gilded itself with 98 per cent of the gold in a solution within 15-20 hours; the Russians think the technique could be used to extract gold from ore. One problem: How do you pin the Order of Lenin on a gold mold?

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STANDARD RAM AIR
Displacement .....400 cu. in.
Horsepower .....366 @ 5100 rpm
Torque .....445 lb.-ft. @ 3600 rpm
Bore & Stroke .....4.12 x 3.75
Deck Clearance ..... .023
Compression Ratio 10.5:1
Chamber Volume .....66.27 cc.
Carburetion .....Quadra-jet, 4-bbl.
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Valve Lifters .....Hydraulic

RAM AIR TRANSMISSIONS
Standard 3-speed Heavy-duty
Make .....Muncie
Shifter .....Hurst
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Make .....Muncie
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Bore & Stroke .....4.12 x 3.75
Deck Clearance ..... .023
Compression Ratio 10.5:1
Chamber Volume .....69.12 cc.
Carburetion .....Quadra-jet, 4-bbl.
Exhaust .....Performance duals
Valve Lifters .....Hydraulic limited travel with manual transmission

RAM AIR IV TRANSMISSIONS
Standard 4-speed Close-ratio
Make .....Muncie
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After a few moments of respectful silence, you may turn the page.

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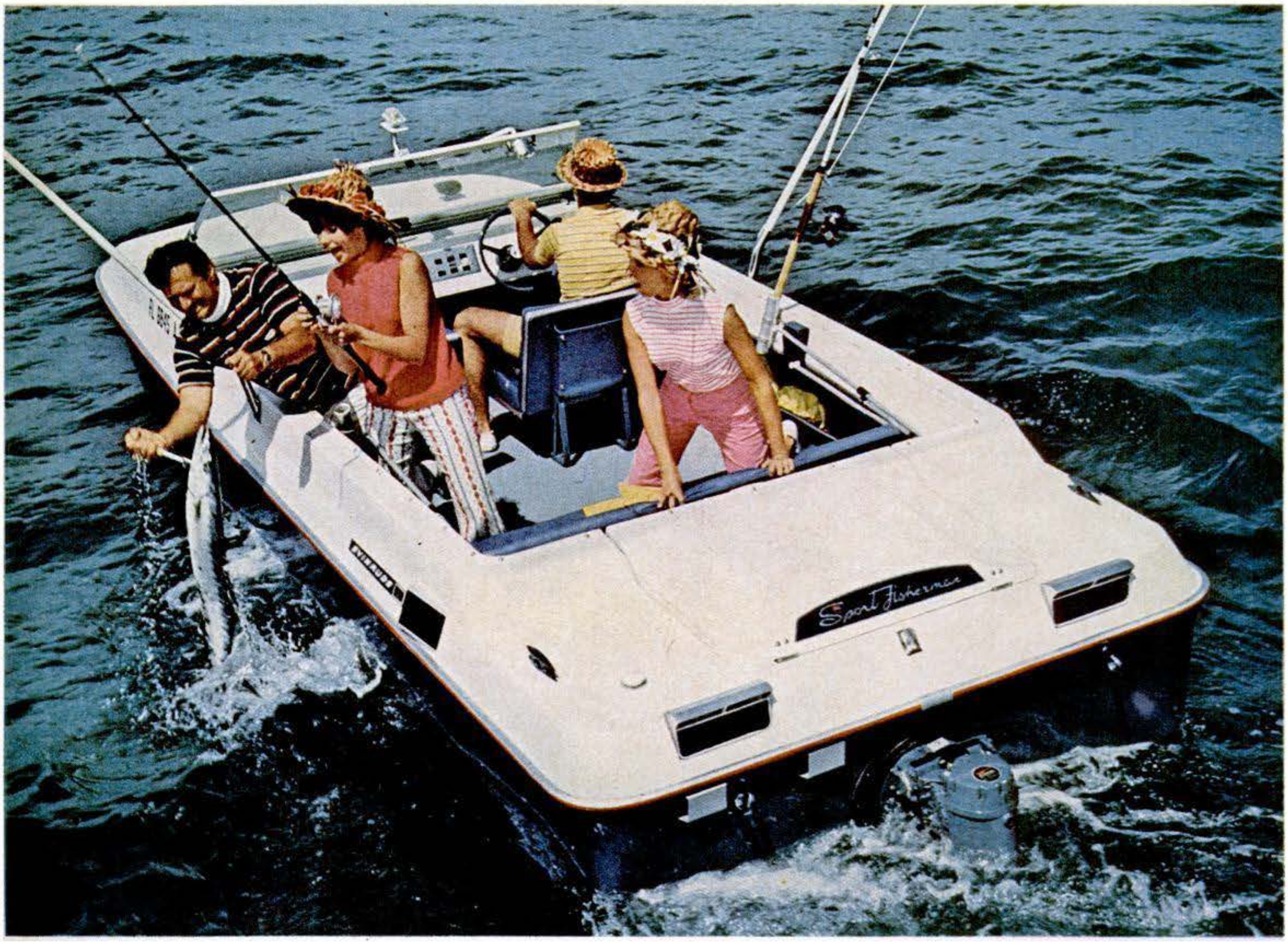

built by fishermen - for fishermen

Coho fishermen are a breed apart from ordinary fishermen. And the 19-foot Evinrude Sport Fisherman was built originally for their special needs.

It's long on comfort. With sure-footed stability and sea-keeping ability — and the ride and room of a conventional boat half again its size.

It combines performance and economy to an exceptional degree — due to an uncommonly efficient match of hull and engine. Just 120 hp moves it at 32 mph. It planes six people at 30 mph. Cruises 144 miles on a single 24 gallon tank of fuel. Trolls all day long on just five gallons.

Everything a fisherman could ask for is at hand. Full instrumentation, including a remote drive-unit position indicator. Finger-tip push-button electric power shifting. And remote electric power tilt.

It comes with high capacity bilge pump and blower. Corrosion-resistant fastenings and hardware. Full length vinyl floor mat. Built-in lifting eyes and cleats. Tinted fold-down windshield. Cockpit floor specially reinforced for a fighting chair. Even a rear-view mirror to watch for action astern.

The Evinrude Sport Fisherman. It started in the cold, rough waters of Coho country — and went on from there.

Write for catalog. Evinrude Motors 4142 N. 27th St., Milwaukee, Wis. 53216

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Your invitation to the world of underwater adventure

SCUBA DIVING for Fun

By CMDR.
SCOTT CARPENTER
USN (RET.)

PHOTO BY JIM DAVIS

Diving is a great idea. You'll see sights you will never forget, live in a world you never knew existed, open up new vistas for your camera, become enthralled by a new way of stalking game. And you will join a fine, fast-growing fraternity that has found scuba diving and spear fishing a healthful, constructive, and immensely satisfying pastime.

But—you don't get all these good things for nothing. Scuba diving requires training, study, planning, and an evermindful eye on safety.

Let's start with the training. You can make it easier by first buying one or two of the good books available on diving. When you have at least briefed yourself on the general nature of the sport, seek out a local diving equipment shop that sponsors a scuba school. If the shop does not conduct classes, the proprietor undoubtedly knows of a club or swimming pool that does.

If you're not a powerful swimmer, don't despair. Swim fins will help tremendously; schooling will do the rest. Any good scuba instructor will make sure that you are sufficiently capable in the water before qualifying you as a safe diver. Pay attention to what he requires of you, particularly anything involving endurance. Fatigue and the panic that result from inefficient swimming and loss of energy are worse killers than the most vicious sharks.

Now you've finished your course of instruction in the swimming pool and —let's hope—have been through one or

[Continued on page 134]

Cmdr. Scott Carpenter, renowned astronaut and aquanaut, prepares to dive. A PS contributing editor, he will regularly cover the exciting undersea world.

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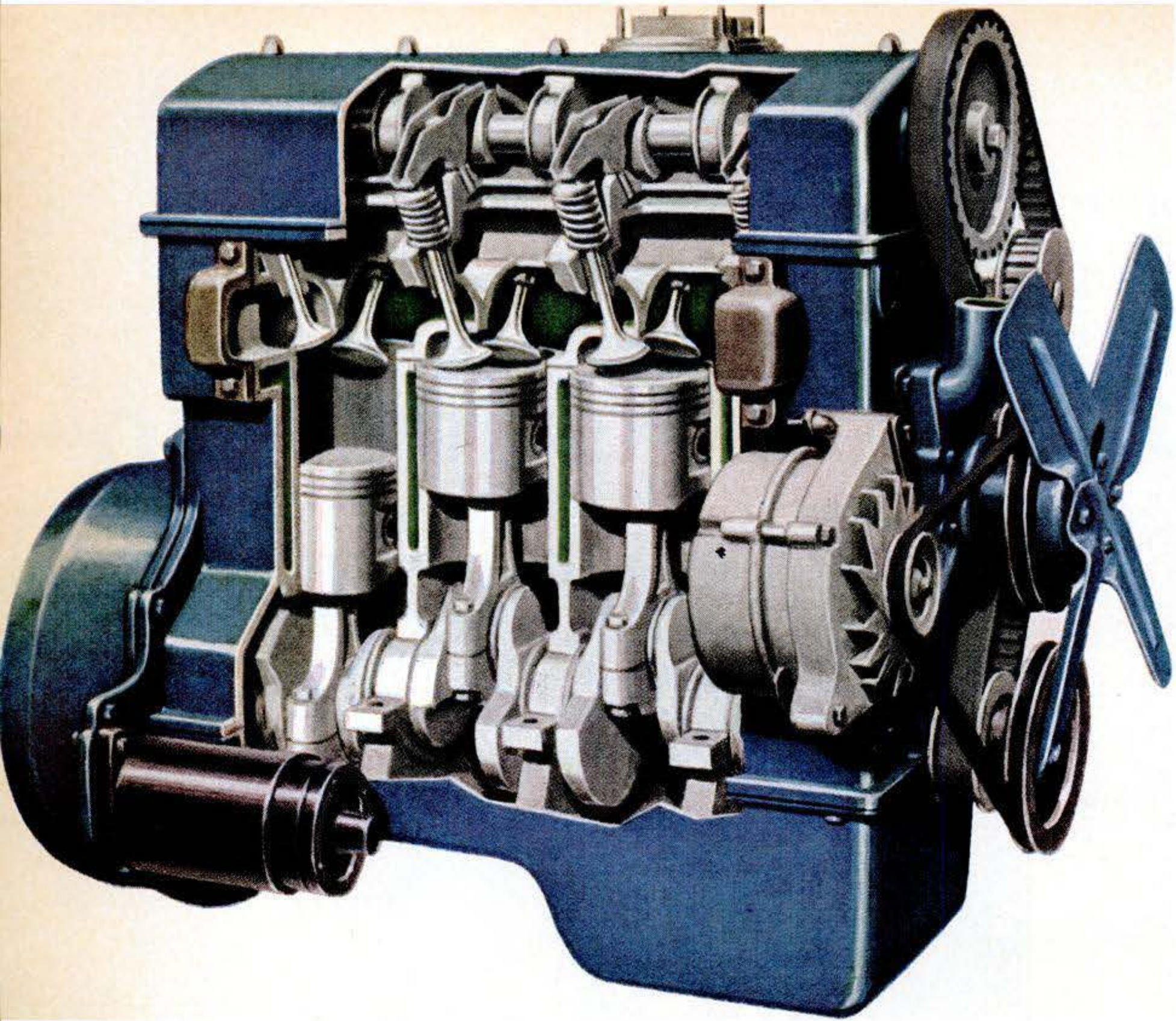
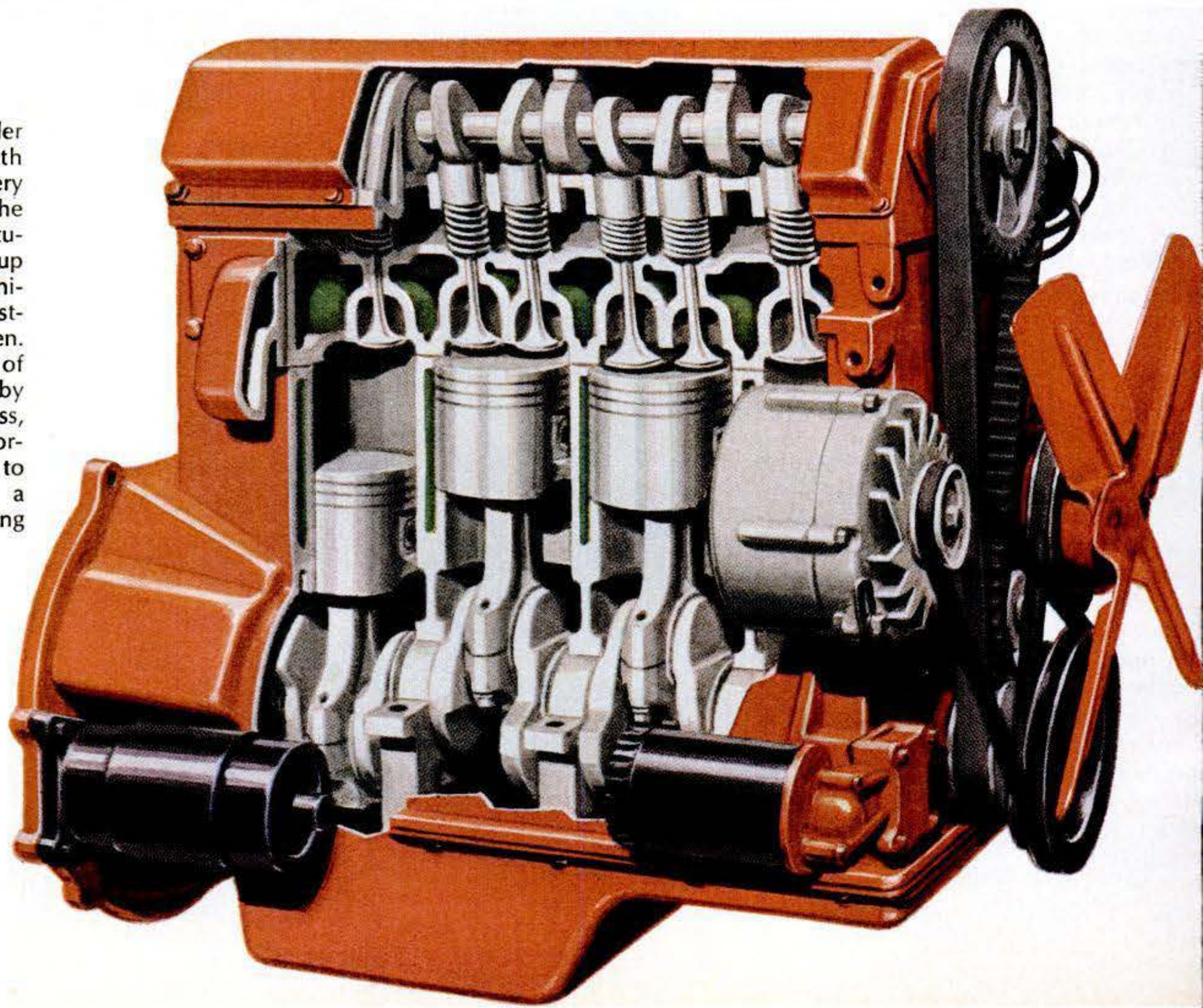


FORD

Four-cylinder 122-cubic-inch engine for the Ford Pony has a crossflow head and inclined valves operated via rocker arms from a single belt-driven overhead camshaft. In typical Ford fashion, the bore is considerably larger than the stroke, and the crankshaft runs in five main bearings. Both block and head are made of nodular cast iron, using the latest lightweight casting techniques. Plans call for this engine to be manufactured in the US for the Pony; in Britain and Germany for other models.

GM

The XP-887 has a four-cylinder 140-cubic-inch engine with valves in line, canted at a very slight angle from vertical. The single overhead camshaft actuates the valves via inverted-cup lifters incorporating an ingenious method of valve-lash adjustment. The camshaft is belt-driven. The cylinder block is made of die-cast aluminum produced by G M 's patented Acurad process, which assures freedom from porosity and full consistency to specification. The alloy has a high silicon content, enabling G M to omit cylinder liners.



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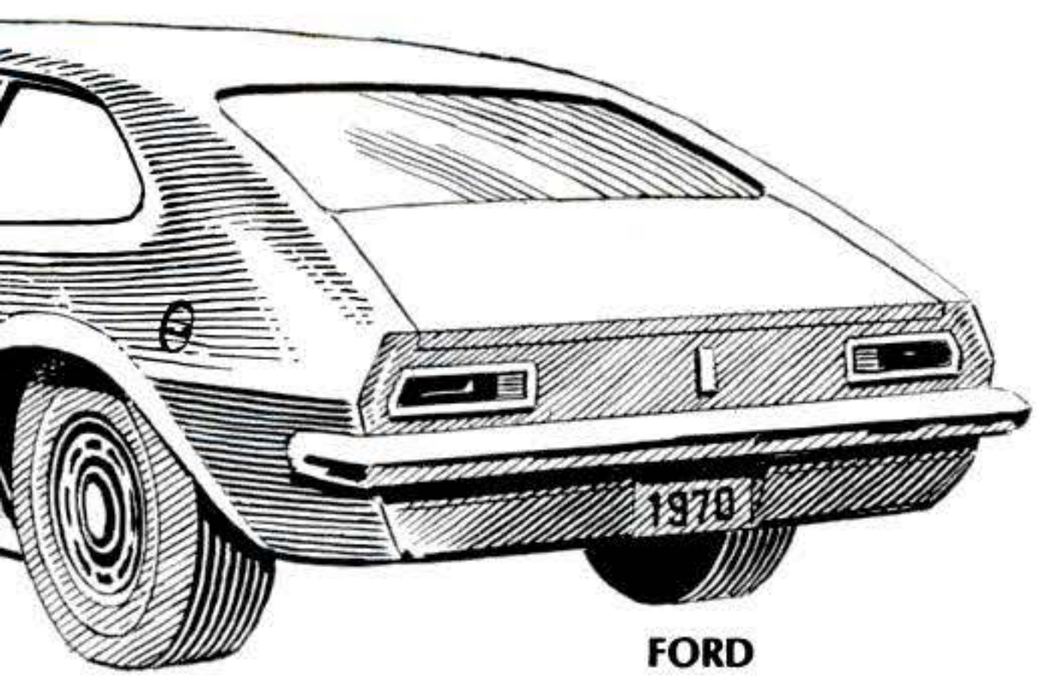
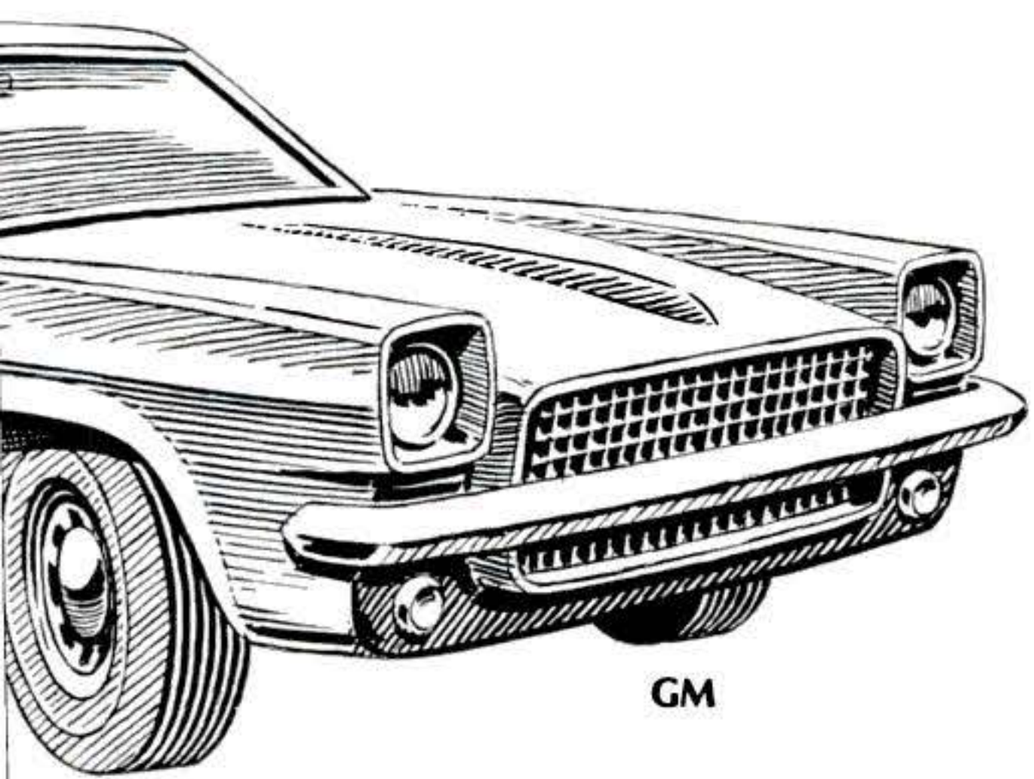
Detroit's New Mini-Compacts

Truly small cars made in U.S.A. are on the way! This exclusive sneak preview, compiled from unofficial information, unveils the full technical details of Detroit's new weapons against foreign cars

By **JIM DUNNE** / *PS Detroit Editor*



FORD



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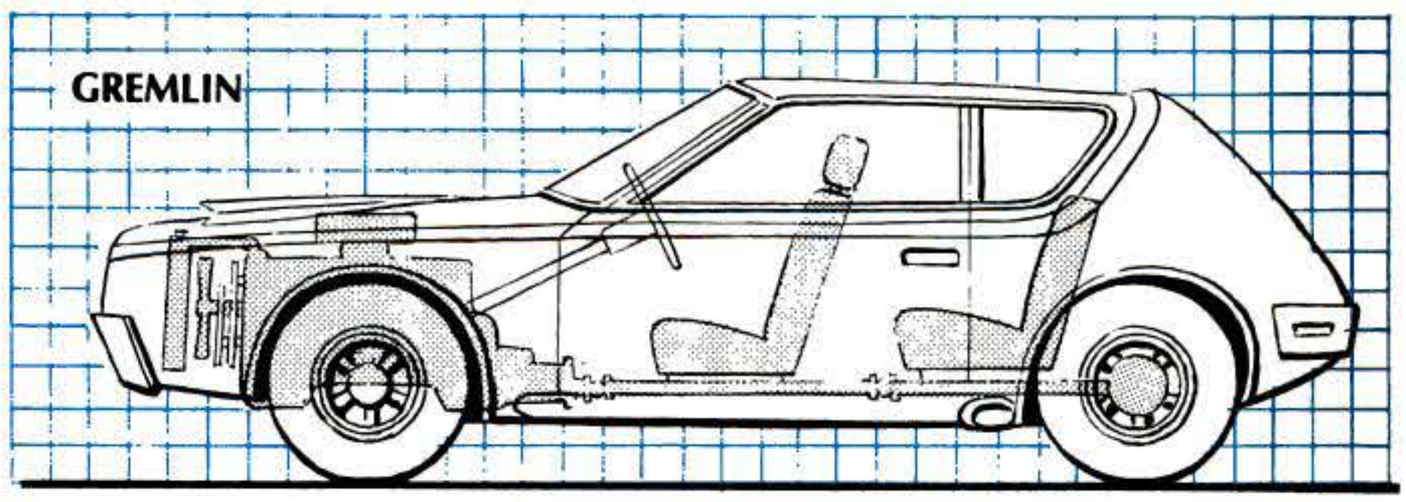
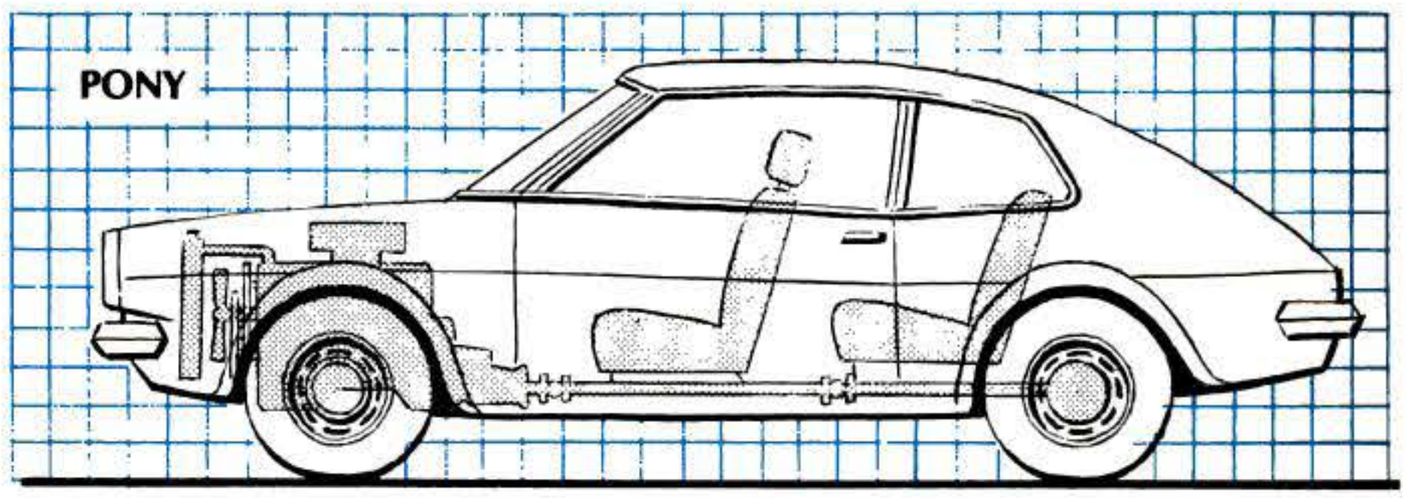


GREMLIN



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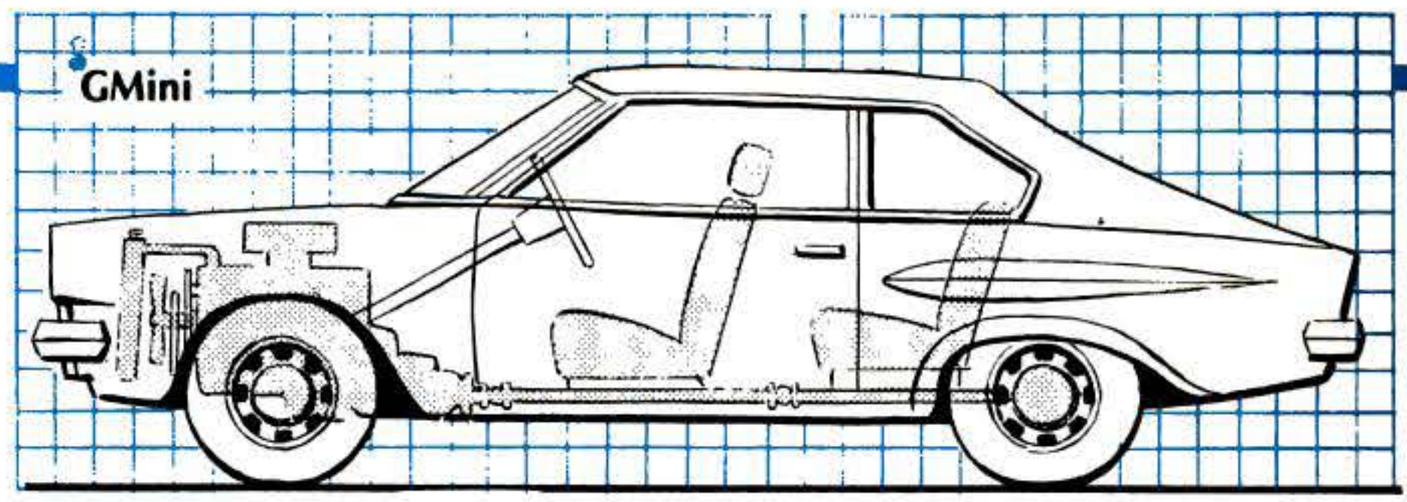
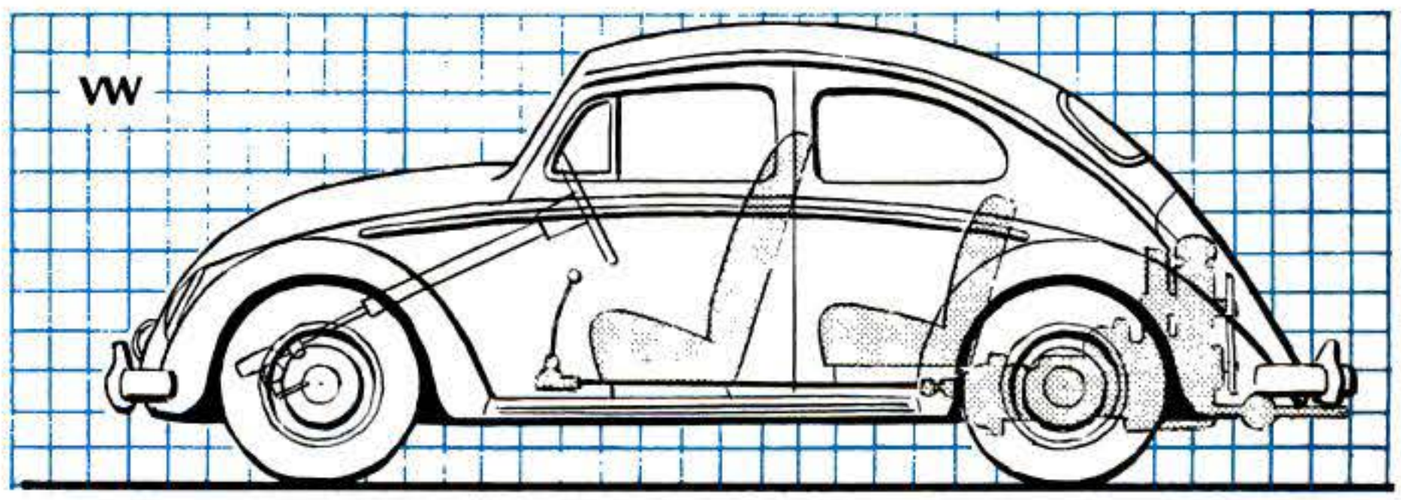


GMini



VW

For over a year, we've been giving you news of domestic small-car projects every month in "Detroit Report." Up to now, the auto makers have changed specifications, body design, and model names with confusing frequency. At last, specifications have been frozen, and I can show you the cars in final form. Only details can be changed from now on.

Detroit's strike back at the imports began with the Maverick's arrival last April and will continue with the showing of American Motors' Gremlin next month, followed by the GMini (code name XP 887) in July '70 and Ford's Pony (earlier Project Phoenix and Special Maverick) in August.

All three are built with a price target of $1,900 or less, and promise true 27 m.p.g. economy. Unlike the Maverick and Hornet [PS, Jan.], the new cars are aimed at the Volkswagen. They will be comparable in size and weight, with superior performance and more practical body design.

Chevrolet corners the GMini. It will be the only division to sell this stylish three-door sedan. The third door is a panel that holds both backlite and trunk lid, like a tailgate. Popular in Europe (used by Autobianchi, Renault, Simca), such doors give station-wagon practicality to the small sedan. GM is expected to make a folding back seat for the new car. Both spare tire and fuel tank are under the flat, wide floor. Pull-out door handles, ab-

[*Continued on page 128*]

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A Sauna

Between dips in the pool, nothing beats a naked bake in dry heat. These are typical California saunas: photo above by Viking, below by Vio

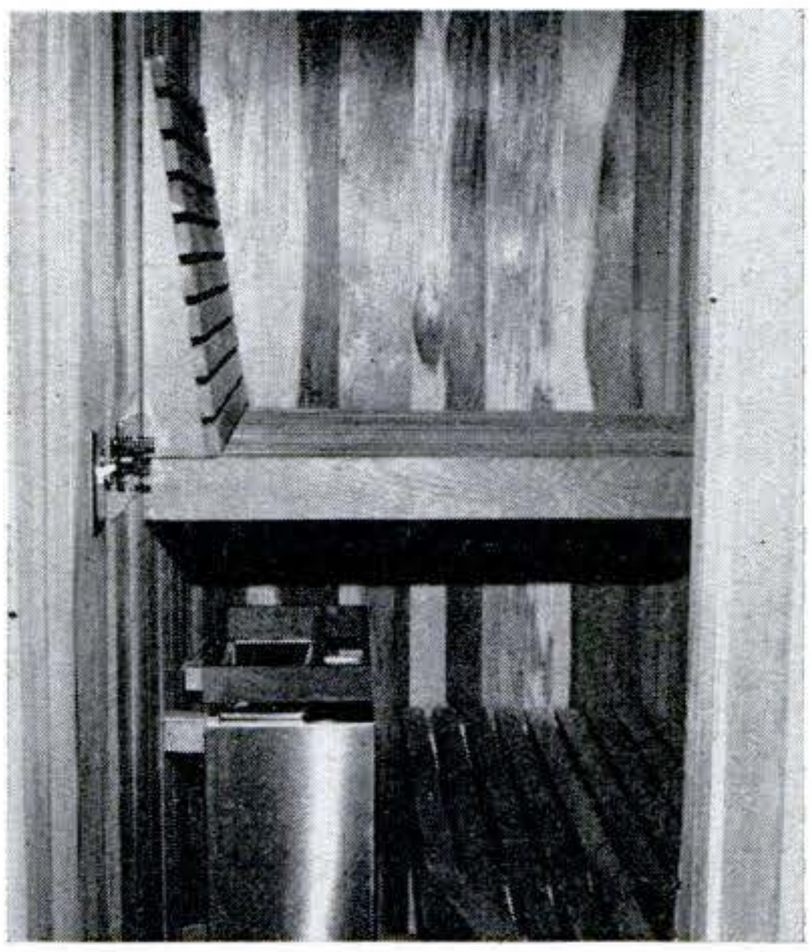
for Your Home?

Our intrepid Workshop Editor, Al Lees—hard at work, right—surveys the dry-bath scene on both coasts and predicts that saunas will be the new status symbol in American homes

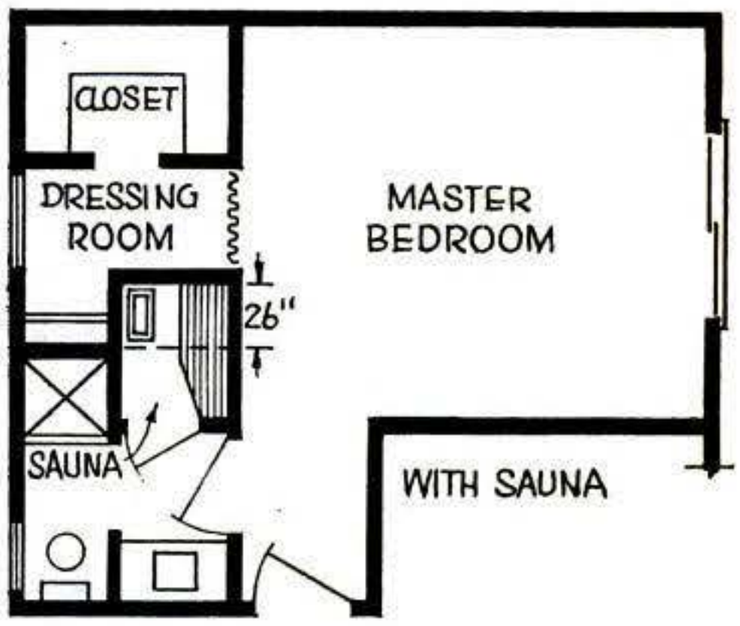
Ignore those wintry weather reports—a heat wave is sweeping across the country from California and may soon reach your home. It's the boom in sauna baths—until recently considered a luxury only to be sampled at resort hotels or health clubs.

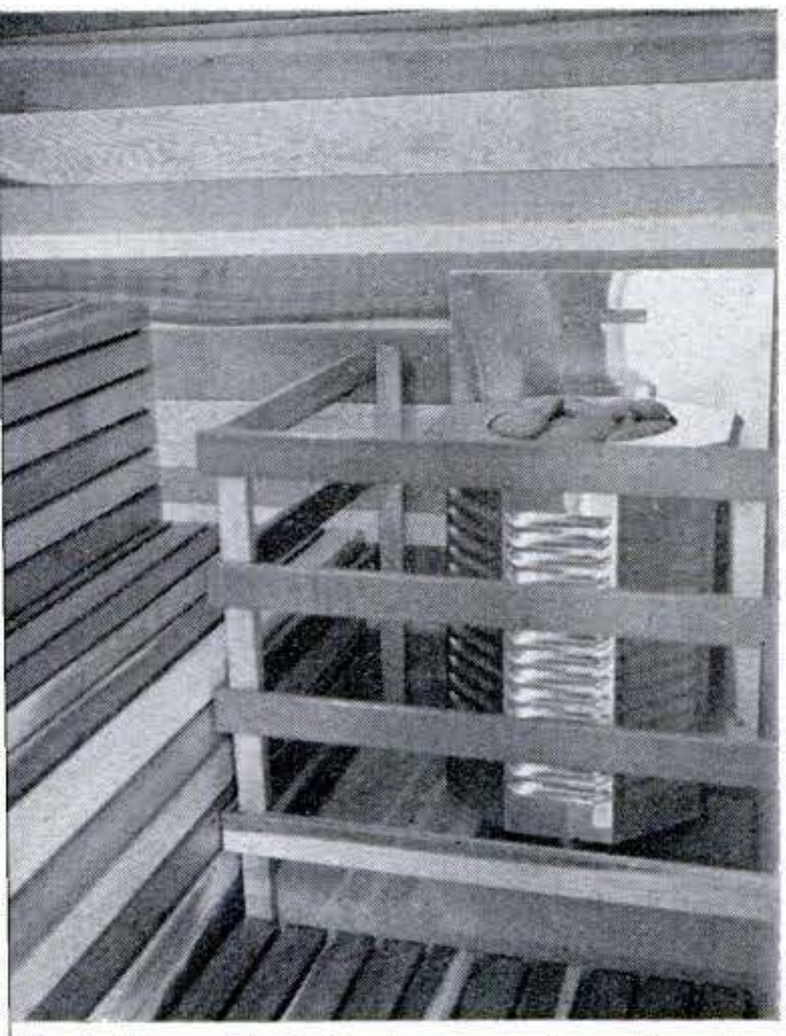
But why a sweat threat from the *west?* After all, the home of the heat-bath is Scandinavia—and has been ever since the Vikings dragged hot stones into sod huts for communal baking. Well, California is the Kingdom of Fads, where "foreign" ideas find fertile ground. I recently spent a week bouncing around its hills, from San Francisco bay to Hollywood, photographing home saunas and interviewing their owners.

I had asked the presidents of three sauna supply companies to show me typical home installations and to let me quiz their customers on the 10 most-asked questions about sauna bathing. I've never encountered such enthusiasm for what is basically a household appliance. Every sauna



Any home has space for a sauna room. This cozy one was wedged into master bath of a San Jose house by borrowing space from an adjacent closet, as floorplans show. Inside dimensions are only 3'-by-4'8" but two can lounge on stacked benches. Viking's smallest (4-kw) heater tucks under top one.





Poolside unit, left, has spacious interior. Only the 7'-by-8' sauna section is shown above. To left of door are shower, toilet. Pool deck hangs out over steep hillside.

Exotic designs abound in owner- or custom-built patio saunas. This polynesian hut perches high above San Francisco Bay, only a few steps across sundeck from bedroom.

Sunken patio beyond master bedroom offers similar privacy to this Japanese bathhouse in Studio City. Sliding shoji doors present a problem of heat-loss insulating, however.

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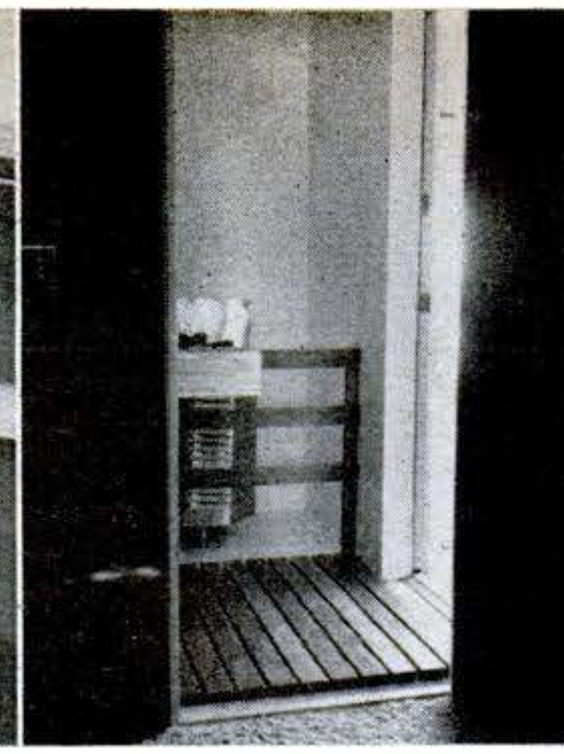
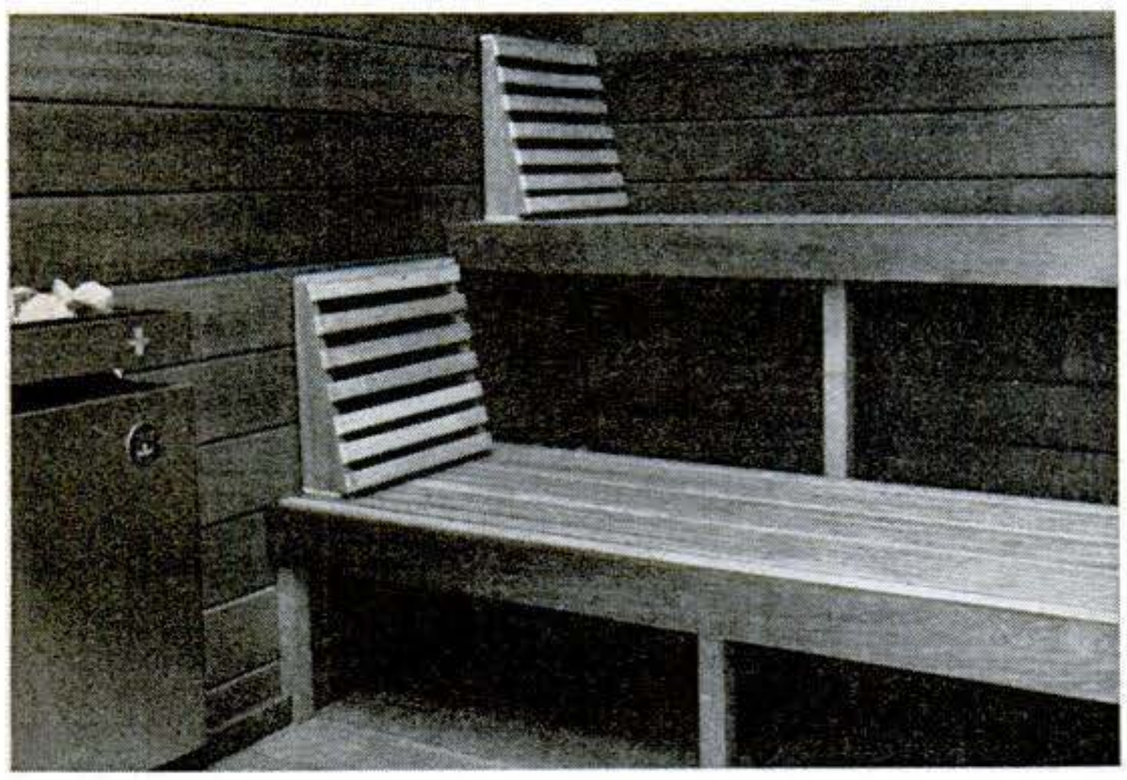


Sauna rooms don't have to have redwood walls

Instant tradition—that's what redwood's become in this first decade of American sauna building; yet it doesn't exist in Finland. Vico promotes three alternatives: Their stainless-steel prefab (left) uses redwood only for duckboards and benches. Beverly Hills installation above (center) has epoxy-coated plywood walls. Benches of sealed pine were built by Finnish owner in authentic step style. Walk-thru sauna (right) in Lake Lindero model home lets you step from bedroom onto pool patio. Plaster-walled sauna is optional in all Lindero homes.

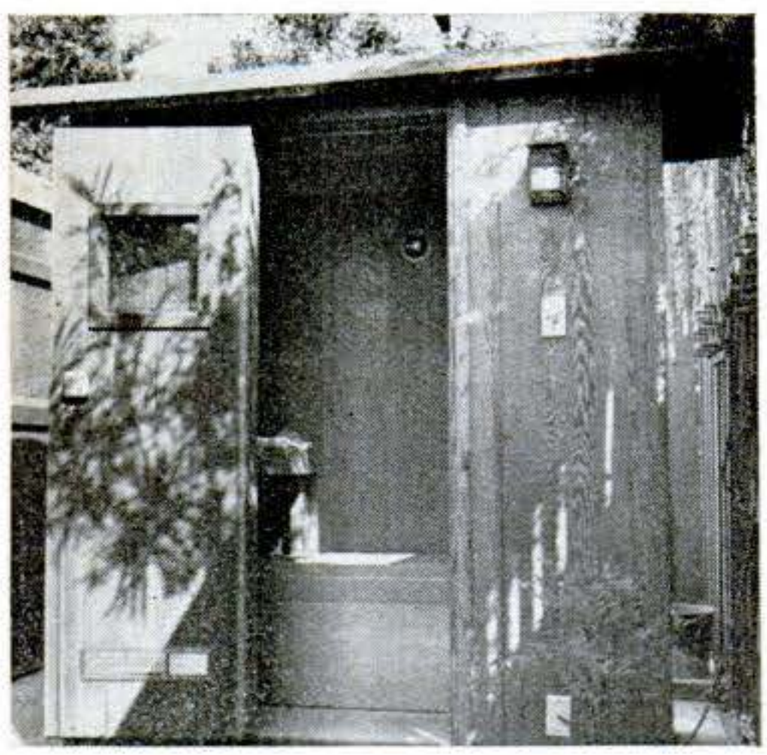
The heaters needn't be space hogs—here are three new slim ones



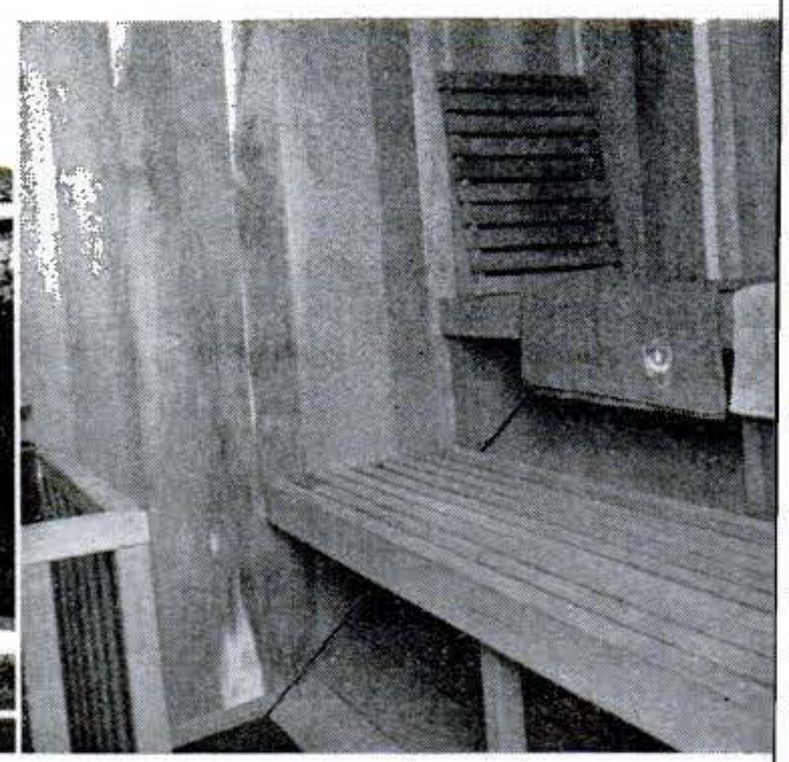
Spacious interior of this sauna in Palo Alto is even more so because of Viking's new close-to-wall stove—important, since room often holds eight guests. Owner did all work himself: Walls are redwood, benches are pine, floor is waxed oak. Vico has similar, trim 6,000- and smaller 1,800- or 3,000-watt units, with stones

Stoveless sauna is new idea from all-electric home in Clifton, N.J. Heat comes from two 1,500-watt Continental Radiant Glassheat panels. No steam option, of course

In-a-door heater, complete controls, turns any closet in solo sauna. Or close in end of hall, as in this Ca home, with unit beside stair



Humble hut in corner of a garden in Atherton is a plug-in 110-volt ready-made; but it was scene of quick recovery from crippling back operation, the nurse-owner told us.



This poolside unit in Los Gatos was owner-built by sales manager for paper company, who tailored it to space occupied by sandbox children had outgrown. They now use it to warm up after before-bed swims. It's popular with adult pool parties, as well. Viking 8,000-watt stove heats it in minutes, helped by inclined redwood floor under benches.

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owner becomes a proselytizer for The Faith. A number of people I interviewed coaxed me into their sweat rooms with glowing reports of the health and tension-easing benefits. I was in and out of my clothes as often as a go-go dancer—with the result that I've become a convert. That sweat threat I spoke of could be the greatest boon to national well-being since the private pool.

The sauna can have similar social benefits, too. I learned that when friends find out you've installed one, they invite themselves in. The key to the current boom in sauna sales may be that America is just becoming ready for such informality. The owner-builder of that poolside unit shown at the bottom of the facing page said:

"A guest at one of our swim parties was a visiting Norwegian who parked his trunks outside the door, insisting there's only one proper way to take a sauna. It sure broke the ice!"

Not that group nudity is essential to sauna socializing. Though the Norwegian was right—you should never wear binding clothes or even jewelry into a sauna—you can provide your guests with big towels for loose draping. Decadent? Hardly; a sauna is no place for an orgy. In fact, while you're baking at 200 degrees *Portnoy's Complaint* and *I Am Curious (Yellow)* seem pretty silly.

But maybe *you* yearn for a sauna as a private retreat. That's surely the motivation for business executives who've installed ones in their private offices. And that's the idea behind the Solo Sauna now offered by one manufacturer. Heater and controls are mounted in the door. You buy a complete 3′-by-3′ sit-down booth, or insulate an existing closet and buy only the door. Wire it into your household current—and you're all set for private rejuvenation.

Just what is a sauna? The word comes from the Finns, and you pronounce it *sow-* (as in female pig) -nuh. In general, it applies to a heated room with a temperature from 165 to 200 degrees—or higher—at a humidity of under 10 percent. (Compare that to a Turkish bath at 120 degrees and swirls of injected steam so thick you can scarcely see or breathe.) You've probably heard of the Finnish ritual, complete with birch-bough flogging, temperatures up to 270, buckets of water tossed on hot stones, and a final race to a snowbank or icy lake to close the pores that all this heat has opened. America has tamed the sauna and turned it from masochism into a pleasant means toward a state of relaxed well-being deeper than any you've experienced.

For answers to the 10 most-asked questions about saunas, see page 140.

New Mini TV: Your "Third Eye"

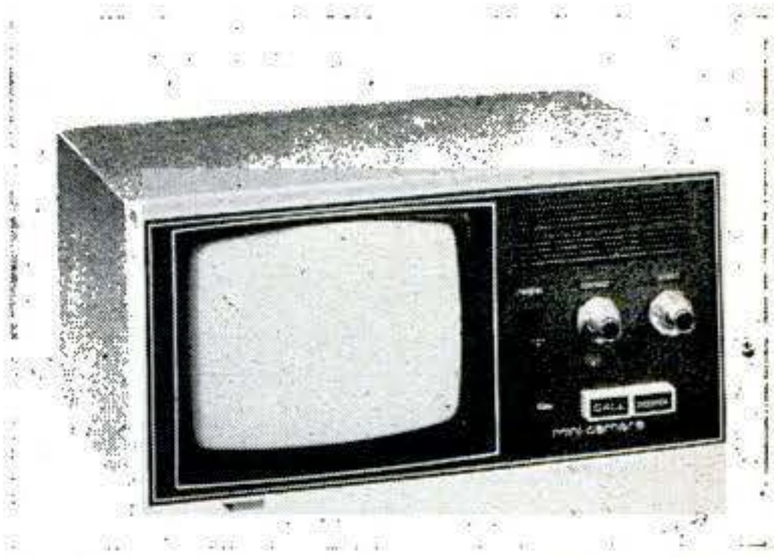
World's smallest, lightest closed-circuit TV system is wired for sound, too

Tony capers for Mini-Scan camera as his mother calmly monitors. Camera works in dim light, sends picture at least 164 feet

Ah, the smell of the greasepaint, the roar of the crowd! Well, not quite. But you can put you and yours "on camera" with the new Sears Mini-Scan 5050. I used this TV with sound as a babysitter, but its applications are limited only by your imagination. Manufactured by Toshiba for Sears, the Mini-Scan Monitoring System includes a TV camera, remote intercom unit, and a 12-pound TV monitor—all for $349.95.

The camera has a viewing angle of 27 or 54 degrees, depending on which lens you choose. The five-inch screen gives a clear, sharp picture. And the controls allow for flexibility of use. For example, you might install the camera in a viewing port at your front door. A visitor who pushed the "call" button would automatically light up your monitor's screen with a picture of himself, and open a sound channel between the two units.—*Arthur Fisher.*

Twist of knob turns up audio signal from remote intercom unit. Message here is "boo."



Toshiba makes Sears unit, sells similar set for business—Watchguard Mini-Camera.

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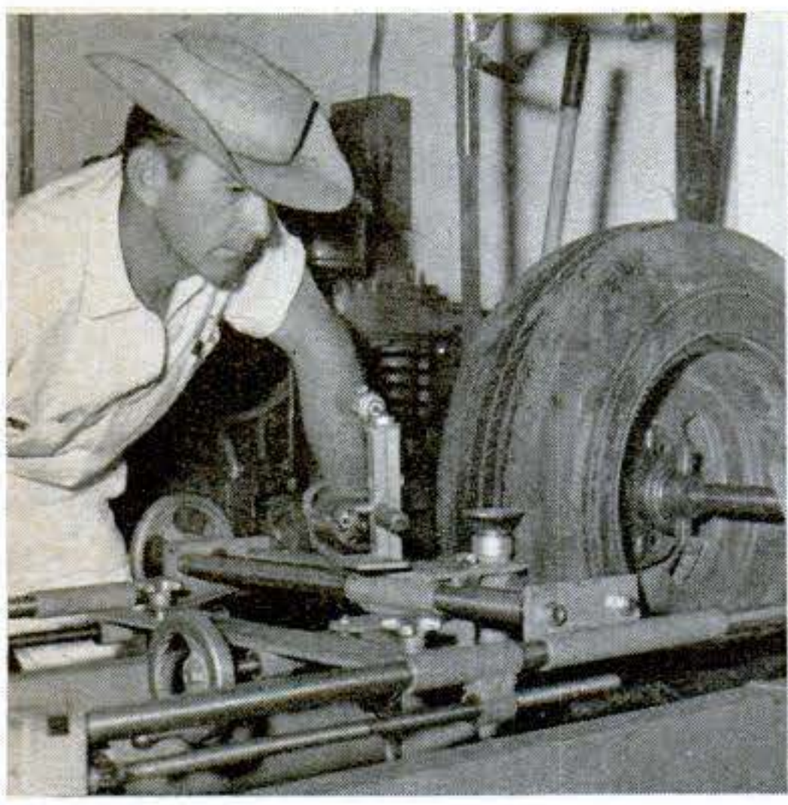
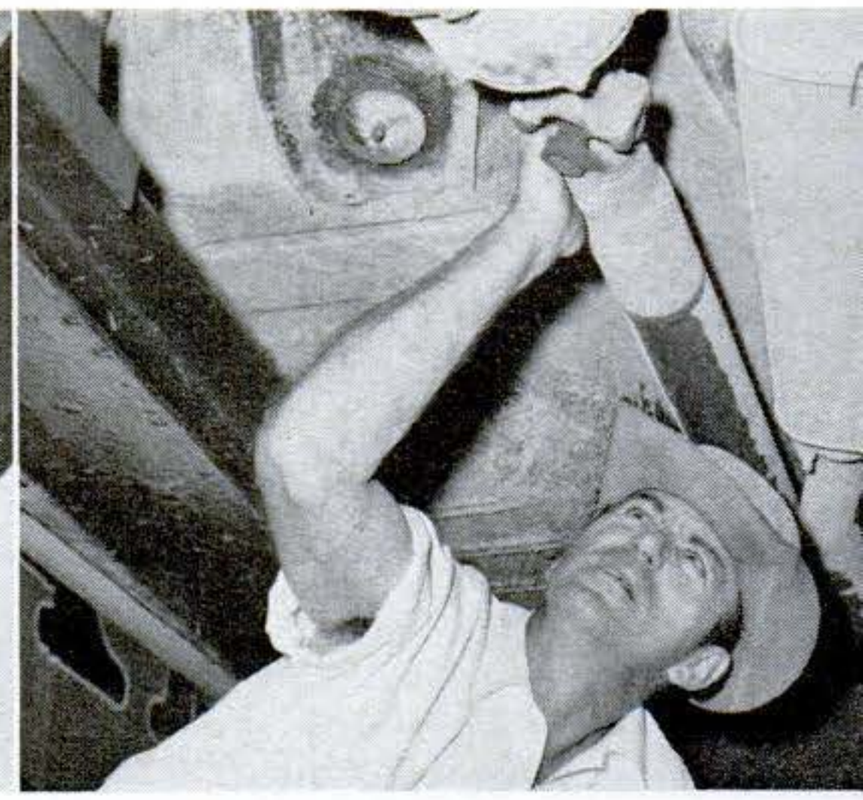
Smokey Answers— Your 8 Most-Asked Auto



Smokey trims a tire for absolute roundness on his tire-trueing machine.

A visual check on the brake lines can spot fluid leaks or possible clogging.



A poorly aligned or unbalanced propeller shaft can set up noise and vibration.

America's top mechanic—our consulting editor on auto mechanics—gives you the straight dope on the most common car problems our readers send in to him

BY SMOKEY YUNICK

Seventy-two times now, counting this month, I've read through a huge stack of your letters about car problems, boiled each stack down to a dozen or so that seemed most urgent, then answered them in my column, "*Say, Smokey—*"

To celebrate my "sixth birthday" with this magazine, and also the new larger size, the Boss said, "Let yourself go, Smokey, take all the space you need and answer in depth the questions most frequently asked by our readers."

I'm taking him up on this offer. I've checked through my backlog of mail from the past six years and come up with eight problems that seem to bother you folks most. Let's start at the heart of the matter:

1 Why does my engine start hard, stall easily, and stumble when I step on the gas?

In hot weather, rough idle and stall at low speed or idle, hard starting, and stalling on slow driving are usually due to expansion and boiling of gasoline from too much heat. It's not too easy to fix, and the problem is aggravated by emission-control devices.

What to do? Use the correct grade fuel. Switch brands until you find the one your car is happiest with, then stick with it. Make sure the exhaust manifold heat riser valve is not stuck shut, and the fan belt isn't slipping.

Poor starting and stalling during cold weather are also tied to gasoline. Gas won't vaporize when it's cold. You can put out a lighted match in an open container of raw gasoline if it is cold enough, though I don't recommend it. So you can imagine how hard it is to fire it up in a cold engine.

Cold-weather starting problems start when raw fuel gets into the cold manifold, then floods the engine, shorting out the plugs. Grinding the starter now only drains the battery. The engine will not start until the fuel evaporates—and that could take days in really cold conditions.

What to do? Try to keep the car in a warm place overnight. Keep your battery, starter, and ignition system in top condition. The choke must be in perfect working condition, or you are in for trouble all winter. The exhaust manifold heat riser and intake air heater play a big part in cold weather, so have them checked. Switch to winter-grade oil, and winter-grade gas. Cold-weather gasoline has a higher vaporizing rate than ordinary.

If you maintain your engine, keeping it tuned to the specs in your manual, you will be a lot less likely to have trouble in any kind of weather.

Don't tinker with your carburetor. Carburetors, as a rule, don't wear out, or go out of adjustment.

2 Why does my engine keep running when I turn off the ignition?

This has become a big problem in the past two or three years, mostly because of emission-control devices. It is worst in hot weather. And it has also been aggravated to some extent by the high compression ratios in some new high-power engines.

Here is how it goes: You turn the ignition off, and the ignition is totally dead and out of the picture. Your engine should stop now, but a hot spot in the combustion chamber provides enough heat to ignite the idle mixture from the carb and your engine keeps running or "dieseling." This ignition from heat often occurs so far ahead of dead center that it can send the engine running backwards. Anti-smog devices have aggravated the problem by further heating the fuel mixture.

There is no universal cure for this problem at this time, though all the auto manufacturers are working hard to overcome it. Many Ford and GM cars now have carburetors with a

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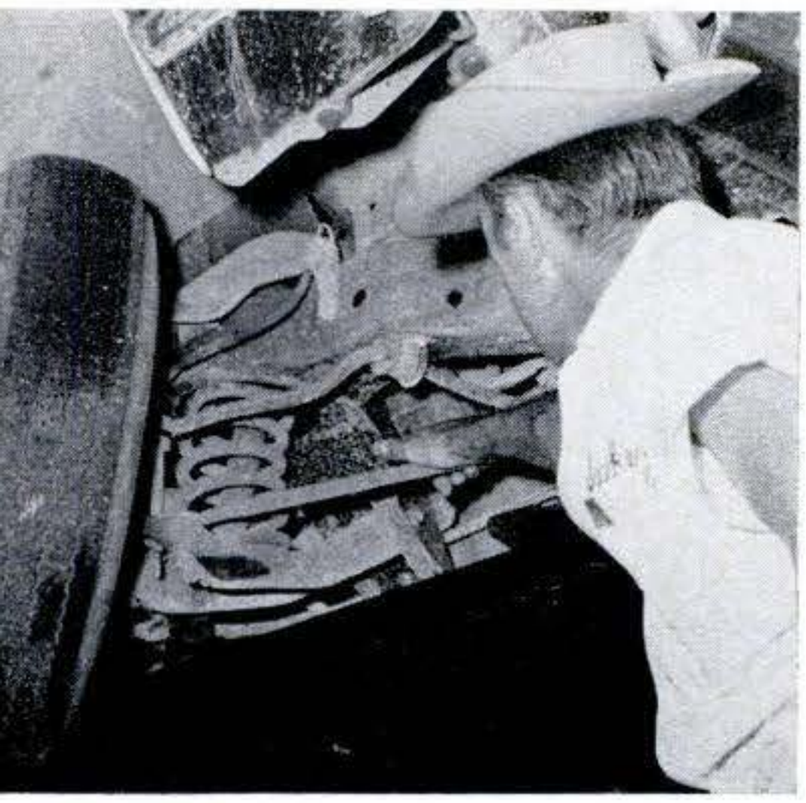
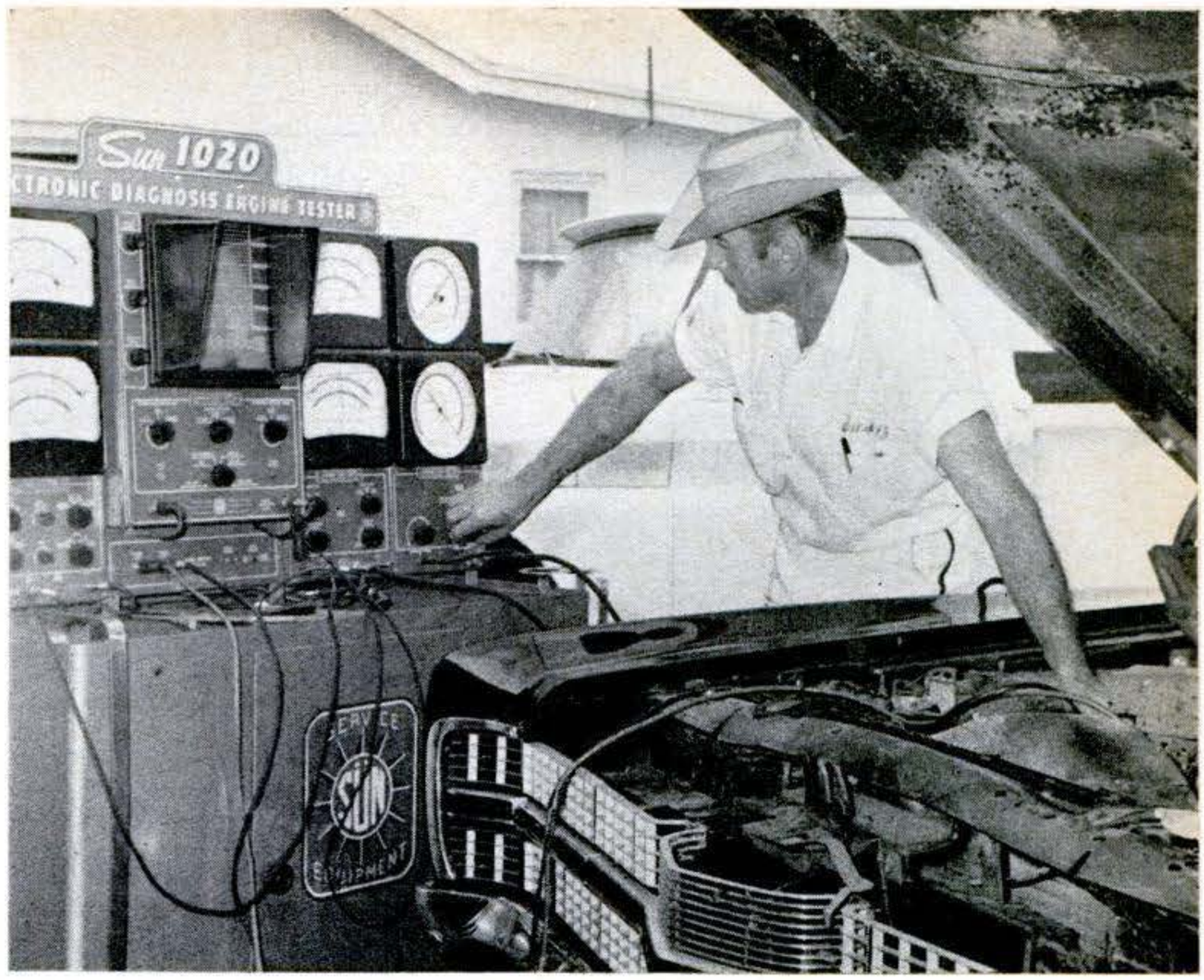
Questions



Bent parts or play in front suspension indicate need for repair or adjustment.



Expert analysis and tuning call for tip-top equipment. With his SunScope, Smokey gets a complete picture of the engine's performance as it's running.

solenoid that allows the throttle valve to close more completely, thus cutting out the idle air supply. Your answer lies with your dealer through factory service bulletins about "Run-ons."

3 Why does my car wander all over the road, even after repeated wheel-alignment checks?

When a car with correct wheel alignment fails to track on straight, smooth roads, you've got a problem. Even the auto makers didn't know how to cope with it until recently. There were bad steering characteristics that couldn't be taken out of certain models, some years back. These came from a combination of three causes: 1. Wrong aerodynamics for a particular model. 2. Poor suspension, springs, and shock-absorber design. 3. Wrong tires for the vehicle.

All these problems are being worked out of newer models, but some of those older models just cannot be fixed.

Before anything can be done about unstable steering, all steering and suspension parts must be within wear limits, then aligned to the manufacturer's specs.

Overload will affect stability because it can send the suspension outside its ride limits. Watch your tire sizes. Different brands, although marked identically, may vary in diameter, and that really fouls up a car's stability. Bad rear alignment can throw you off course, too.

After you've gone through all the above, if your steering is still not up to snuff, all I can add is to look for a good trade for a model with proper steering.

Of course there is the "Let's-make-it-stiffer" school. Those people go in for heavier shocks, springs, and sway bars, which help a little if you don't mind the harder ride. But if you go this route, you had better consider just how critical the correct suspension geometry is, and have the beef-up done by an expert suspension man. Otherwise the job will be not only hopeless, but maybe even dangerous.

4 What causes a car to pull to one side under braking, and the brakes to squeal and groan?

Here I have to say in all honesty that much can be blamed on poor design, or a cut-rate fix by an incompetent mechanic, but the rest of the blame will have to go to you, the driver. You can ruin linings on a new car (or new linings on an oldie) in the first couple of days of driving if you don't run them in right. Take it easy for the first 40 or 50 stops, at least. New linings contact the drum only with 20-30 percent of their surface. In hard and frequent stops, the small area of contact causes a higher-than-normal heat build-up through friction.

This chars or burns the shoes. The followup is greatly reduced stopping power. Before you get off the ground your lining job is shot.

Watch out for the bargain-basement brake job. Good linings cost the repair shop about $20. Taking in the price of labor and overhead, guess what you are going to get for about $12.95 at the cut-rate shop? Something not much better than cardboard, I'll bet. And linings are only a part of the job. The only way a relining job can be done right is to have all the drums with correct finish, and linings matched to the drum radius. Hydraulic parts in all four wheels should be closely examined and repaired if necessary. The mechanic should check the wheel bearings and seals, and all the hydraulic lines involved with application of pressure, for leaks. The condition of the flex lines is very important, and all these lines should also be checked over for possible plugging.

A good job may cost you about $100 nowadays. It's a lot of money, but still cheaper than hospital fees!

The problem of pulling to one side is very dangerous, so don't put off a brake job if that's your problem. A complete overhaul of brakes is called for. Don't overlook the chance of there being faulty suspension parts in this connection.

In some rugged parts of the country, and especially where the added load of stopping while pulling a heavy

[Continued on page 138]

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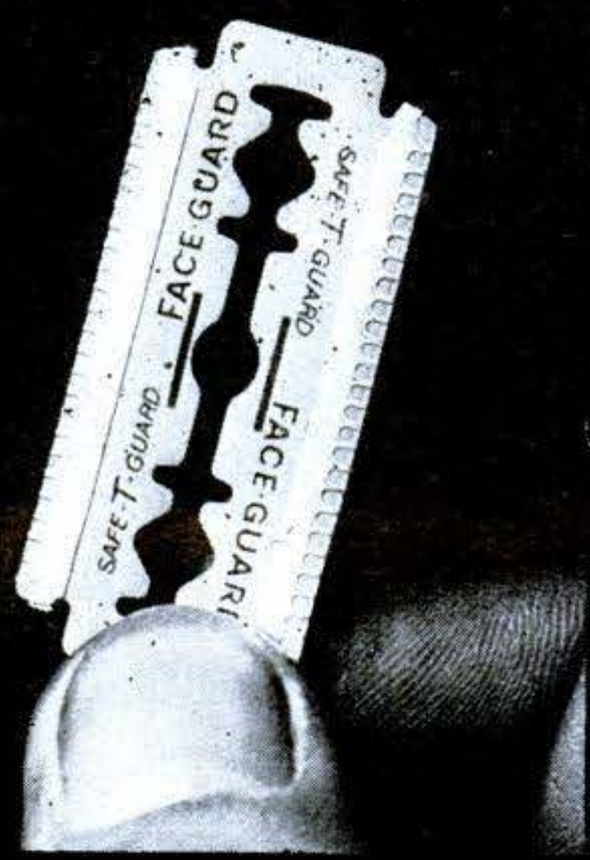
Science Gives You a

Injector-razor users can get chrome-edged blades from Personna (top) and Schick. But only Schick makes chrome-edged band blades (bottom).



Personna's chrome-edged Face-Guard blade has an aluminum guard that the maker says protects your skin and reduces nicks by over 80 percent.

By HERBERT SHULDINER

Ninety comfortable shaves on a blade. Sound incredible? Well, that's how many some men report they can get out of one of the new chrome-edged blades that you've been hearing so much about lately.

The new blades are made possible by a recent technical breakthrough that lets manufacturers sputter a film of chrome or chrome-alloy onto blade edges.

Until now, razor blades have always been sharpened by removing metal to form a cutting edge. The starting thickness of a razor blade is 0.004 inches. Grinding, honing, and stropping ultimately produce an edge that is about 20 millionths of an inch thick. The longer you retain the final shape of this edge, the longer it will remain an effective cutting instrument.

But the edge is so fragile and prone to damage from skin acid, soap corrosion, whisker nicks, and abrasion from skin that it can easily lose its sharpness. So the manufacturers are now adding an ultra-thin metallic film to the edge —about 300 angstroms (an angstrom is a little bigger than a millionth of an inch) of chromium, or platinum-chromium. Theoretically, this makes the edge duller. But for all practical purposes, sharpness is unaffected. The chrome reproduces the stainless-steel edge, even fills in some voids created by the original grinding. This adds considerable strength to the edge. The chrome also retards acid damage because it is many times more resistant to corrosion than stainless steel. Therefore, you get a harder edge that is less likely to deteriorate from mechanical damage or the effects of corrosion.

The first of this new type, Krona-Chrome blades, were put on sale last year by Schick. Personna's Ultra-Chrome and Wilkinson's Chromium Edged blades followed. And Gillette has recently put a platinum-chrome-alloy-edged blade on the market which it calls Platinum-Plus.

All four manufacturers report that their test-shaving panels are getting anywhere from 20 to 30 percent more comfortable shaves out of each blade, on the average.

Assuredly, not all shavers will find the new blades such an improvement. Shaving comfort is as much influenced by the kind of beard and shape of face you have, even your psychological feelings, as it is by the keen edge of a blade. So it's not surprising that a small percentage of shavers don't benefit from the new blades. But most others are finding that it's not unusual to get two or even three, weeks of smooth shaving out of a new chrome-, or chrome-alloy-edged blade.

This notable jump in blade life makes for the biggest development in wet-shaving hardware since Wilkinson introduced plastic-coated stainless steel blades in 1963. What's more, it augurs even greater changes in the near future, which could result in better long-lasting blades.

What's behind this technical breakthrough? The sputtering process takes place in a vacuum chamber. The exact process used by each company is its closely guarded secret. But with the help of the Bendix company, which manufactures the sputtering equipment that is used by several blade companies we're able to describe the essential steps that go into putting a chrome edge on blades.

Before being placed in the vacuum

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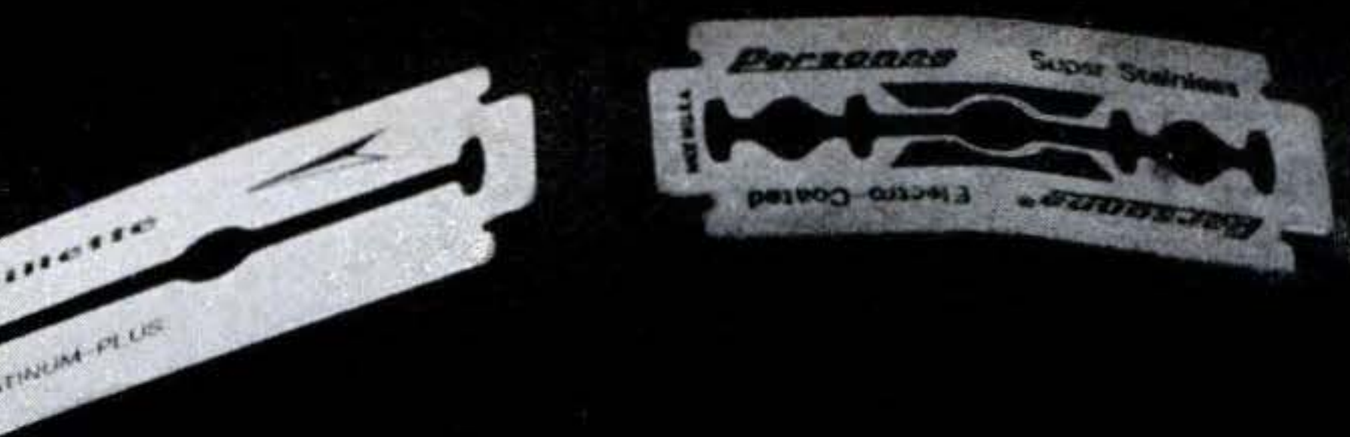


Here's the inside story on those new blades and how their edges are being sputtered with metal alloys to make them give you lots more comfortable shaves

New Edge on Shaving

mber, the sharpened blades are ned both by dipping and passing n through a mist of trichloroethylene solvent. That's because the blades t be extremely clean in order for chrome, or chrome alloy, to fuse the stainless steel.

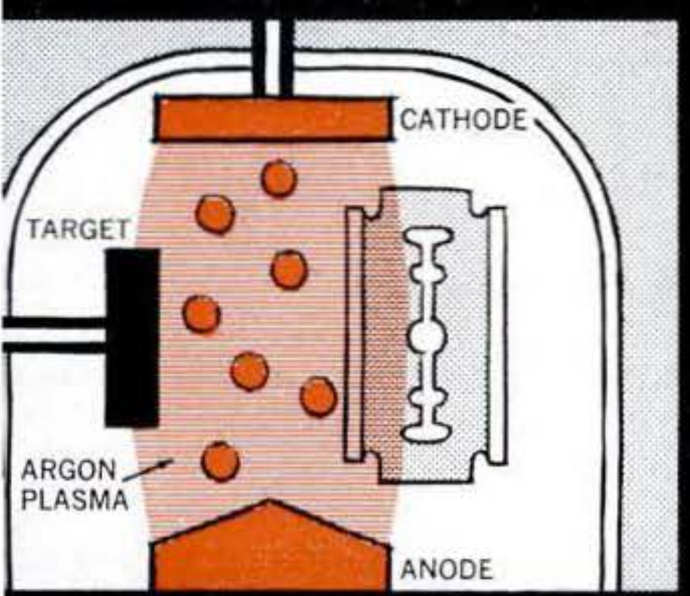
hen an inert gas—argon—is pumped the chamber and excited with an tric charge that creates a plasma. ted ions of argon plasma further n the blades of any atomic particles irt that might be left after the tri-roethylene bath and spray. Then the tively charged argon ions slam into egatively charged "target" of chro-m- or platinum-chromium alloy ch is also in the chamber, and tear e particles from it. These atoms fly ery high speeds through the plasma embed themselves in the stainless-l blade edge.

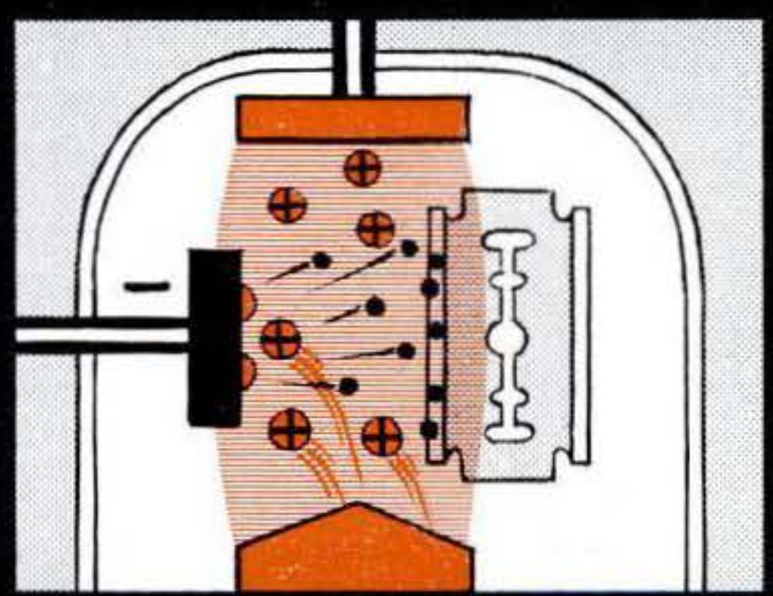
nce the metal particles can be loos-d only when the target is charged, chromium can be put on the blade e with absolute precision. The unt of chromium deposition is ely controlled merely by switching the target current source on and off.

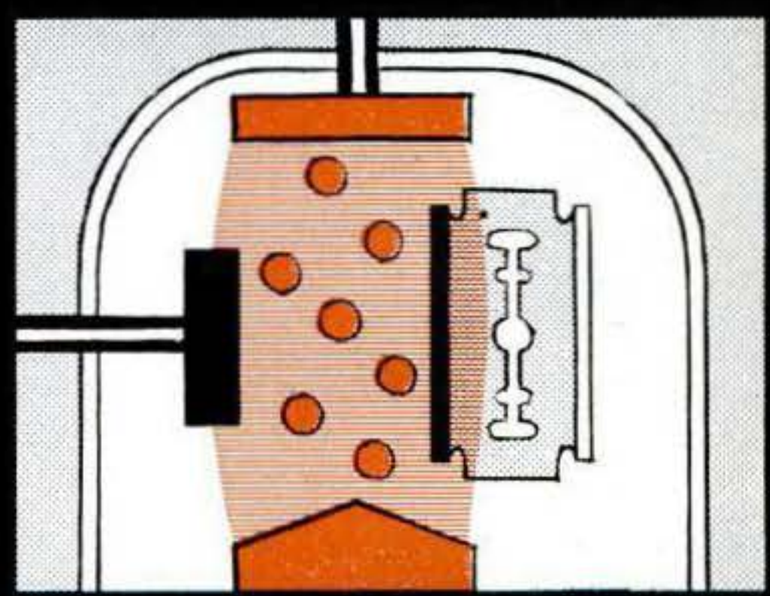
The resulting chromium edge is chemically clean, so it also improves the final step in the manufacture of blades. This is the application of a coating of Teflon over the edge. The Teflon coating, first introduced on Gillette's Super Blue blades in 1959, is the substance that cuts blade drag on your skin. Coating a blade edge with Teflon is like putting ice on cement to cut friction drag. It reduces the amount of force you have to place on the blade to make it cut. The super-clean chromium film provides a better bond for Teflon than ordinary stainless steel.

The chromium and platinum-chromium alloys are merely the first substances to be sputtered on blade edges, industry sources say. They are already thinking of sputtering other metals, ceramics, or even glass onto blade edges in the hope of coming up with even longer-lasting blades.

The chrome-, or platinum-chrome-edged blades will cost you a little more than stainless-steel blades do. However, if you get more shaves per blade, it might actually turn out your cost per shave is lower. Schick's Krona-Chrome blades are four for 89 cents, the same price as five Schick stainless blades. Gillette's Platinum-Plus blades are five for $1. Five Gillette stainless blades cost 79 cents. Wilkinson's new blades are five for 89 cents, versus 79 cents for five stainless. Personna's Ultra-Chrome blades cost no more than its stainless blades — five for 79 cents.







sputtering works: Argon gas in vacuum ber is ionized by hot filament cathode rm plasma. Argon ions "sweep" dirt blade. When chrome target is charged negatively, it attracts positive argon ions, which bump particles of chrome or platinum-chrome off it. These coat blade edge. Although metallic particles fly at high speed through plasma, precision coating is made possible by switching current source for target on and off. Argon ions won't dislodge particles unless target is charged.

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Surprising Facts We're Learning from the

Intriguingly different from what anyone had expected, the lunar rocks and other evidence gathered by our Apollos boost hopes of solving the mysteries of the solar system

By
DR. WERNHER VON BRAUN

Director of NASA's Marshall Space Flight Center, Dr. von Braun has a special place in history as head of the Saturn V team whose rockets have put our astronauts on the moon. As our Consulting Editor on Space, he contributes frequent articles on exciting developments in the space program.

Puzzling recordings of Apollo moonquake detector, watched as they come in at Houston by Dr. Gary Latham (left), now are explained by Apollo 12 test that made the moon ring like a bell.

From a height of 68 miles the unmanned and discarded ascent stage of Apollo 12's Lunar Module hurtled to a 3,750-mph crash on the moon. The 2½-ton craft's impact, 45 miles from the Ocean of Storms site where Conrad and Bean had just set up a new "moonquake detector," was equivalent to a ton of exploding TNT.

The object of the deliberate crash was to see what the instrument would report to earth, and the result astounded scientists. The moon rang like a bell! On earth, tremors from such an impact would have died out in a minute; on the moon they lasted almost an hour. Something about the moon's interior was new to science.

The moon is proving a wonderland of surprises. First came the unanticipated discoveries by the first moonmen, Apollo 11's Armstrong and Aldrin. Now Apollo 12 is adding more as its moon instruments report, and as experts examine its rich new haul of moon rocks—about double Apollo 11's booty of 47 pounds.

And that fulfills just what the most optimistic scientists had hoped—to find the moon so unlike the earth that our lunar explorers' finds could not have been foreseen. For its surprises, especially, promise the best chance of solving such mysteries as how the moon, earth, and solar system began.

Pieces of the moon tell their secrets. As this was written, detailed findings of the 142 investigators studying Apollo 11's moon rocks were about to be made public in a January conference at Houston. By agreement with NASA, the scientists were to keep mum until then. But NASA's own Preliminary Examination team, which studied the moon rocks intensively at Houston so that the right ones would go to the right scientists, had already announced a variety of striking discoveries:

Even the first, cursory inspection of Apollo 11's lunar-soil samples brought a surprise. Much of the looser soil consisted of tiny balls of glass, ranging up to a millimeter (about 1/25 inch) in size, and from "lemon-drop" yellow to deep reddish-brown in color. Acting like ball bearings, these unanticipated "moon beads" clearly accounted for the slippery footing Armstrong had reported in walking on the moon. And Apollo 12's astronauts, landing on the left side of the moon's face instead of the right, found them there, too.

Glistening in sunlight like light-reflecting glass beads in a highway sign, the "moon beads" excited scientists because they showed something unforeseen was happening on the moon. While theories varied, one held that impacts of meteorites melted silica-rich lunar soil to glass. A molten blob, thrown up and falling back in a vacuum, would be transformed by surface tension into a perfect sphere before it hit the ground.

Moon samples, like the astronauts themselves, underwent a three-week quarantine before release to the outside world. Tests showed they contained no living or-

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Astounding age is most surprising property of these crystalline Apollo 11 moon rocks.

Moon Landings

"Moon beads" of glass, magnified here more than 100 times, were unanticipated discovery by Apollo 11 on lunar surface. Apollo 12 found them, too. They explain slippery footing reported by the astronauts, who, in effect, were walking on ball bearings.

ganisms, nor even fossils, and exposure to moon soil had no ill effects on people, animals, or plants. That was no surprise. The real upset was that lunar material did have an effect—a beneficial one!—on plants like lettuce, tobacco, beans, and tomatoes. For example, tobacco had greener leaves, and lettuce seeds germinated better, in soil sprinkled with Apollo 11 moon dust. At this writing, biologists were still mystified, and could only conjecture that "trace elements" might have something to do with it.

Drops of "solder"—from a solar flare-up? Mysterious glazed spots resembling splashes of molten solder were found on the moon's surface both by Apollo 11 and 12—and pictured close-up with a "walking-stick" stereo camera. Some thought the glinting spangles, like moon beads, were spatterings of glass by meteorites. But the odd fact that they were invariably at the bottom of a small pit or crater led Cornell astronomer Thomas Gold to propose a more dramatic explanation:

A giant solar flare lasting 10 to 100 seconds, and packing perhaps 100 times the normal solar radiation, Dr. Gold suggested, melted the tips of rocks and of soil hummocks to form the glazed spots. Collision of a comet or

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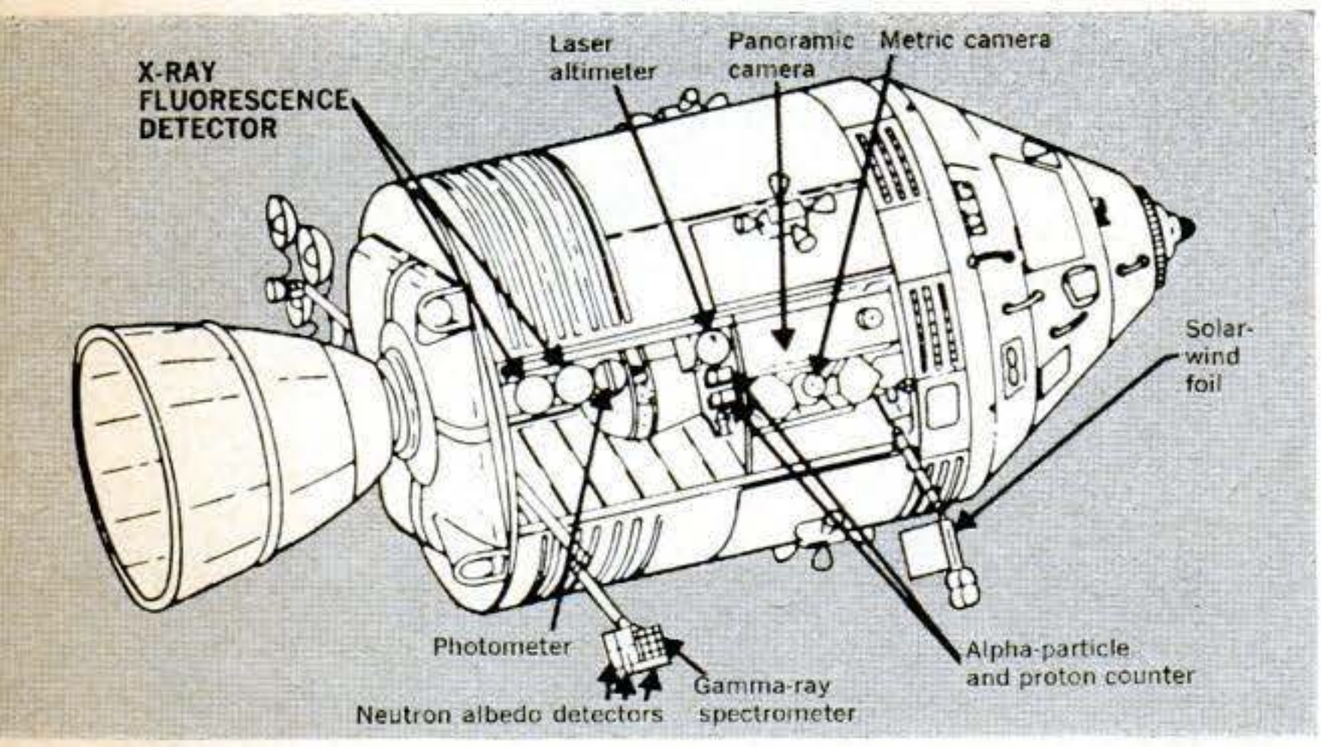
Plants grown in soil sprinkled with lunar dust, like sorghum and tobacco above, surprisingly thrived better than in plain earth.



To map moon's minerals from lunar orbit, this new gear for Apollo Command and Service Module would include remote sensors such as a detector for rocks' fluorescence under solar X rays.

asteroid with the sun might have triggered the flare. Its heat would have been trapped most effectively at the bottom of pits, where the drops of "solder" were found. Since they have survived incessant bombardment by micrometeorites, he concluded, this event must have happened fairly recently—perhaps less than 30,000 years ago, in the time of Neanderthal man.

Why haven't signs of it been found on earth, then? If the heat pulse were largely of ultraviolet radiation, as Dr. Gold surmises, our atmosphere would have shielded the earth from it—but the airless moon would have borne the full brunt.

Unearthly rocks. Surprises continued as analysts got down to work on the composition of Apollo 11's lunar rocks. Principal ingredients proved to be two silicate minerals, pyroxene and feldspar, and the titanium-bearing mineral ilmenite. Minor constituents included minerals known as olivine and cristobalite; almost certainly, native iron, and troilite (rare on earth except in meteorites); and a yellow crystalline mineral, not immediately identified.

What was unearthly was, first, the rocks' astonishing richness in titanium. They contained up to 12 percent of titanium oxide, compared to less than 10 percent for the richest terrestrial specimens. If Sea of Tranquillity soil were on an earthly beach, experts commented, you'd have a fine titanium mine.

Compared both to earth rocks and meteorites, the moon rocks proved unique, in their abundant content of high-melting-point elements—zirconium, chromium, and others besides titanium—and deficiency in low-melting-point ones like sodium, potassium, and lead. That made it look as if they were formed from a different molten magma, or by a different natural process, than any rocks we have known before. Seeking to learn how they came into being would be an intriguing quest.

Apollo 11's moon rocks, it proves, lack any gold, silver, or platinum—and, of more practical importance on the moon, any hydrated minerals that could be "mined" for water. There has been no water on the lunar surface at Tranquillity Base, geologists conclude, in the 20 to 160 million years that the rocks have lain there (a period estimated from isotopes produced by cosmic rays). But Apollo 12 shows how different even another "mare" area of the moon may be:

Almost all of Apollo 12's rocks are "igneous"—formed from molten lava, and still in their original crystalline form. This is a dramatic contrast to the Apollo 11 site, where both igneous rocks and another kind, called breccias, abounded. The breccias are cemented-together aggregates of lunar-soil particles—probably fused into solid rock by the shock of meteoric impacts. So you would expect to find them everywhere on the moon. Their scarcity in the Ocean of Storms is as surprising as would be a spot in the ocean floor where drills found no sediment.

Moreover, the first close look at Apollo 12's magnificent haul of rock specimens suggested their make-up would differ widely from Apollo 11's. By early estimates they might contain no more than an earthly two percent of titanium oxide; while perhaps 15 percent of olivine would contrast with that silicate mineral's scarcity in Apollo 11 samples. The 20th-century New World of the moon is proving a world of many faces.

Rocks' exciting age may disclose the past. Probably the moon rocks' most exciting surprise of all is their fabulous age. It may well make them the Rosetta Stone to bare the mysterious history of the moon, earth, and planets. This is the view of Prof. Robert Jastrow, the brilliant director of the Institute for Space Studies at NASA's Goddard Space Flight Center.

A comparatively rough-and-ready dating technique called the potassium-argon method, used in the preliminary examination of Apollo 11's igneous rocks, indicated that they crystallized three to four billion years ago. If the latter, they antedate any rocks known on earth. And future specimens from the lunar highlands, supposedly older than the "young" Sea of Tranquillity region, may take us back to the very beginning of the solar system—which, from studies of meteorites, is put at some 4½ billion years ago.

[More-precise dating methods at two laboratories have since pushed back the age of Apollo 11 rocks to a sensational *4½ billion years*—the age of the solar system itself—according to an unofficial advance "leak" of scientific investigators' later findings. The report was tacitly confirmed when Dr. Eugene M. Shoemaker, Caltech geologist and NASA consultant, predicted that this fantastic age would be the one accepted "when all the evidence is in."—*The Editors.*]

Listeners on earth followed first-hand the brilliant success of Apollo 12's moonmen in recovering parts of the Surveyor 3 spacecraft, to see what had happened to machinery exposed since 1967 to the moon's "weather." But a trophy perhaps as noteworthy was a photo of an imprint left by a bouncing Surveyor footpad. After 2½ years the one-foot-diameter impression remained as fresh as a newly minted coin, unscathed by any meteoric impact—proof positive of how long a target of known area could escape a hit. It was a statistic of no small interest to coming moon travelers and builders of moon shelters.

"Prospecting Apollos." Future explorers of lunar natural resources will need geologic maps to guide them

[Continued on page 144]

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perpendicular to the plane of the crystal sheet.)

This is how. Exactly how are the bubbles manipulated? Mr. Bobeck and two of his colleagues at Bell Labs, together with William Shockley—a Nobel Laureate for his work on the transistor—were recently issued a patent covering magnetic bubble technology. There are circuits to propagate bubbles, and circuits—called "bubble eaters"—to consume them. The bubbles behave like charged particles, and can be herded about by the judicious nips of applied magnetic fields, generated by pulses of electric current sent through printed circuits on the surface of the chip. One such circuit is the shift register pictured on page 65.

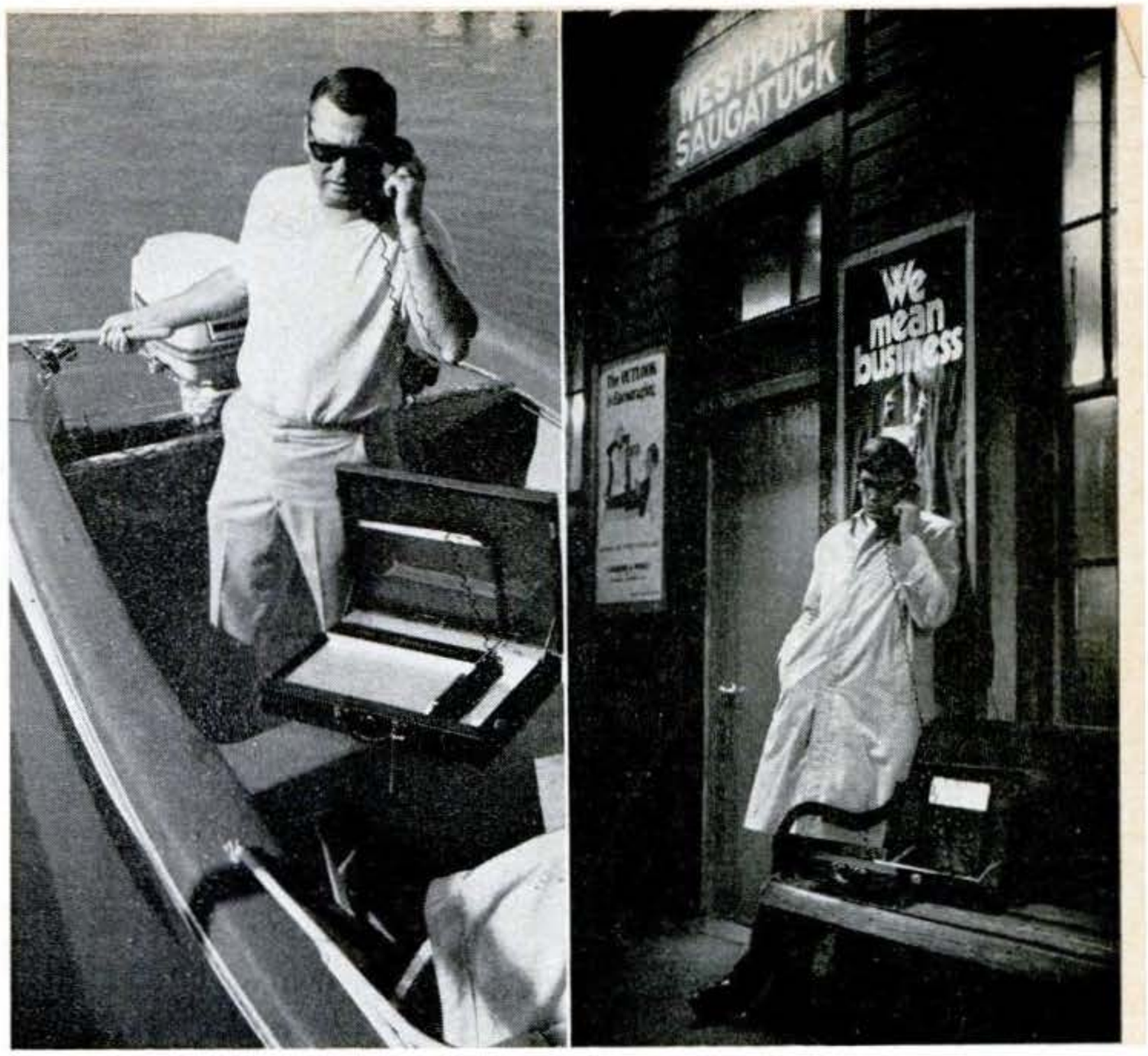
Two other techniques for manipulating the bubbles consist of elegant and ingenious magnetic "tricks."

The first is called the angelfish circuit, because of a fancied resemblance to angelfish of the triangular permalloy wedges you see in the photo at the bottom of page 66. The idea here is that it is much easier for a bubble to slide off the point of such a wedge than it is to leave the blunt end. Suppose we embed a chain of these angelfish in the surface of our chip. Now, if the magnetic bias field is decreased, the bubble will swell, and straddle three of the wedges, finally sliding off the point of one. Then, if the bias is increased, the bubble will shrink and again slide off a point. With each oscillation of the bias field, the bubble moves one step. Under the microscope, this looks exactly like the motion of a bloated inchworm, and it is so called by the Bell experimenters.

The second circuit. This uses a rotating field in the plane of the chip to produce varying magnetic poles in a series of T and bar-shaped permalloy metal pieces in the chip. As the field rotates, the bubble is alternately attracted and repelled, thereby moving along a prescribed path, as shown in the diagram on page 66.

As Messrs. Bobeck and Morton would be the first to admit, magnetic bubble technology has some way to go before it can fulfill its great promise. For one thing, Bell scientists have yet to grow orthoferrite crystals large enough to satisfy them.

"Magnetic bubbles are more a potential than an actual achievement," Mr. Morton summed up, "but who could tell in 1948 that transistorized computers would land on the moon?" Much work remains before magnetic-bubble devices can be shown to be practical for use in computer or communications systems. But their adaptability, simplicity, small size, low power, low cost may some day open up a new world of electronics technology. PS



Your phone follows wherever you go so you can always keep in touch—out in your boat, or late at night. Phone weighs 11.4 pounds with rechargeable battery.

The Briefcase Phone: Talk From Anywhere to Anyone

There's a briefcase you can buy that lets you send and receive telephone calls wherever you are, whatever you're doing—trolling on a quiet lake, checking construction sites, or riding in your car.

What's in the case? Basically a battery-powered radiophone with FM receiver and transmitter. It's really more complicated than that, though. For example, there's a voice-activated transmitter switch (like those used by the Apollo astronauts) to conserve battery power.

How does it work? To make a call, you press a button. A mobile operator comes on the line and connects you to your desired number. From then on you talk as you would with an ordinary phone. When you receive a call, a tone sounds and a light goes on.

Where will it work? Anywhere within range of a mobile operator, and that means almost anywhere in the country. Outdoors, the antenna built into the case works fine, but when riding in a car you'll need to hook up the accessory antenna. Steel-frame buildings will block the signal.

Made by Melabs, a subsidiary of SCM, the attache phone is available through Hammacher Schlemmer, 147 E. 57 St., New York City 10022. Price? Around $2,500. About 650 have been sold.

Pushbuttons activate phone and select communications channels. Meter (at top) indicates battery charge.

When you get a call, light on case goes on. If you aren't there to answer, it stays on until you return.

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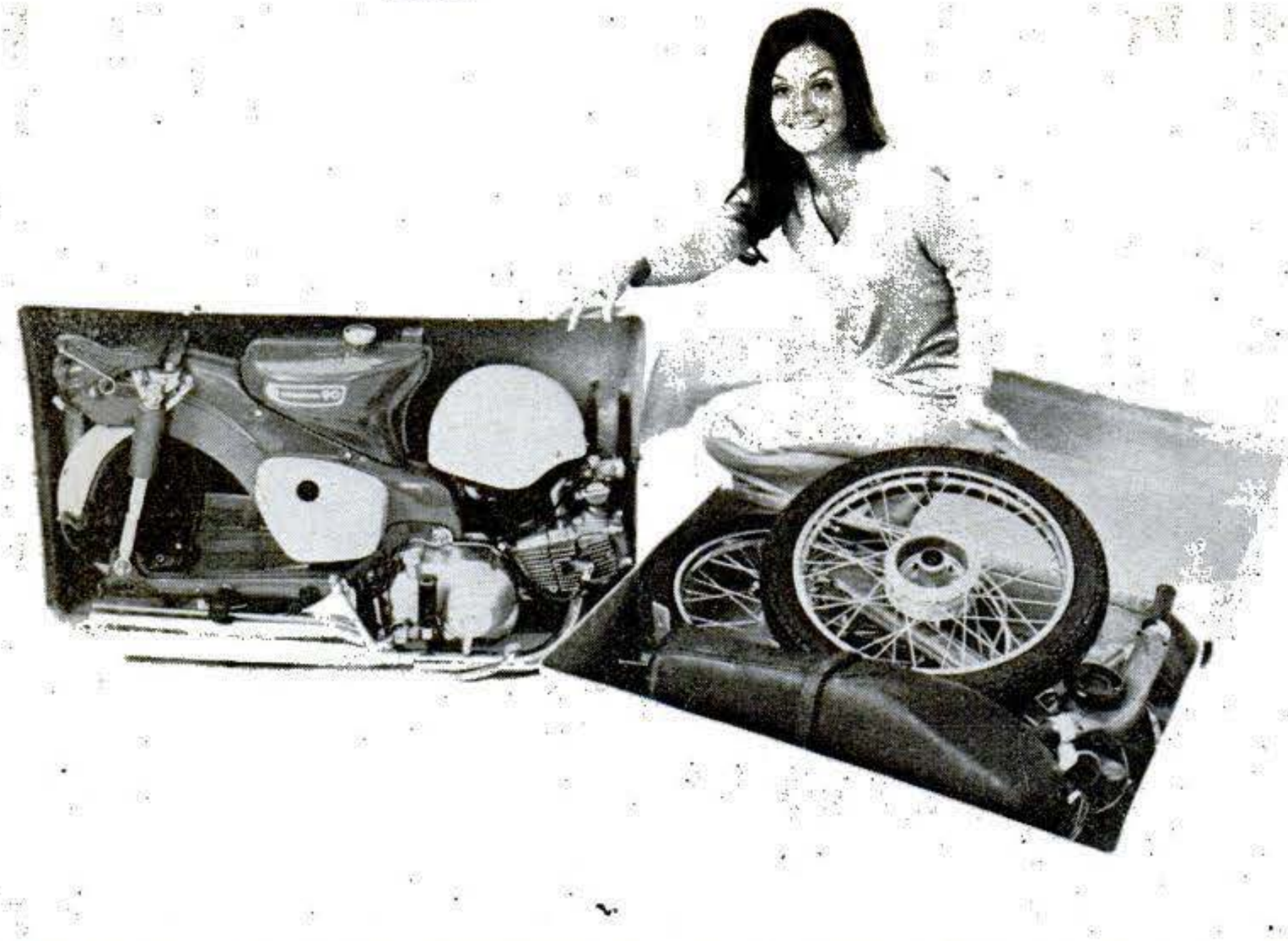

There's a Honda 90 in those two fiberglass cases. It's been modified to break down in two minutes without tools. Cases have room for your helmet and saddlebags, too.

On board your boat, a suitcase cycle will give you a bike in every port.

You're Never Without Wheels

"Your flight leaves in 20 minutes, sir. Do you have any baggage to check?"

"Just these two suitcases, but be careful with them—my motorcycle's in there."

Sounds unlikely? Not since S & K Air Sea Cycles started modifying small Hondas to break in half and fit in two fiberglass suitcases. Once cased, the bikes are easy to take along wherever you travel—in your car, boat, private plane, even on commercial transportation. To make toting the bikes even easier, S & K put wheels on the cases so you can roll them right up to the baggage counter.

You don't need tools. The bikes—Honda 50- and 90cc models, or the 90cc Trail—break down without tools in two minutes. Reassembly takes

Take-along thermostat needs no wires to dial temperature.

You can dial the temperature you want anywhere in the house with this new take-along thermostat. It's as portable and easy to use as a pocket transistor radio. In fact it, too, works by radio waves.

I've been using one in my house for several months. We take the SpaceTemp 100 control unit where the action is; we're no longer in the grip of our old fixed thermostat on the dining-room wall. It not only gives accurate control of the temperature of the room we're in, it's always at hand to change the temperature to suit our activity—warmer for watching TV, say, or cooler for playing Ping-Pong. It can control both a central heating system or central air conditioning, and do it with equal efficiency.

Installation? About 10 minutes. There's none for the thermostat itself of course, since it's wireless, portable, and battery powered. The responder unit is hung on the wall anywhere that gives access to your present thermostat wires—usually near your furnace. Connect two thermostat wires to the labeled terminals, plug the line cord into an AC outlet, and you've got take-along temperature control. The battery in the thermostat lasts a year.

The SpaceTemp is made by Kimco Laboratories, 5721 18th Avenue, Brooklyn, N.Y. 11204.—*Hubert Luckett.*

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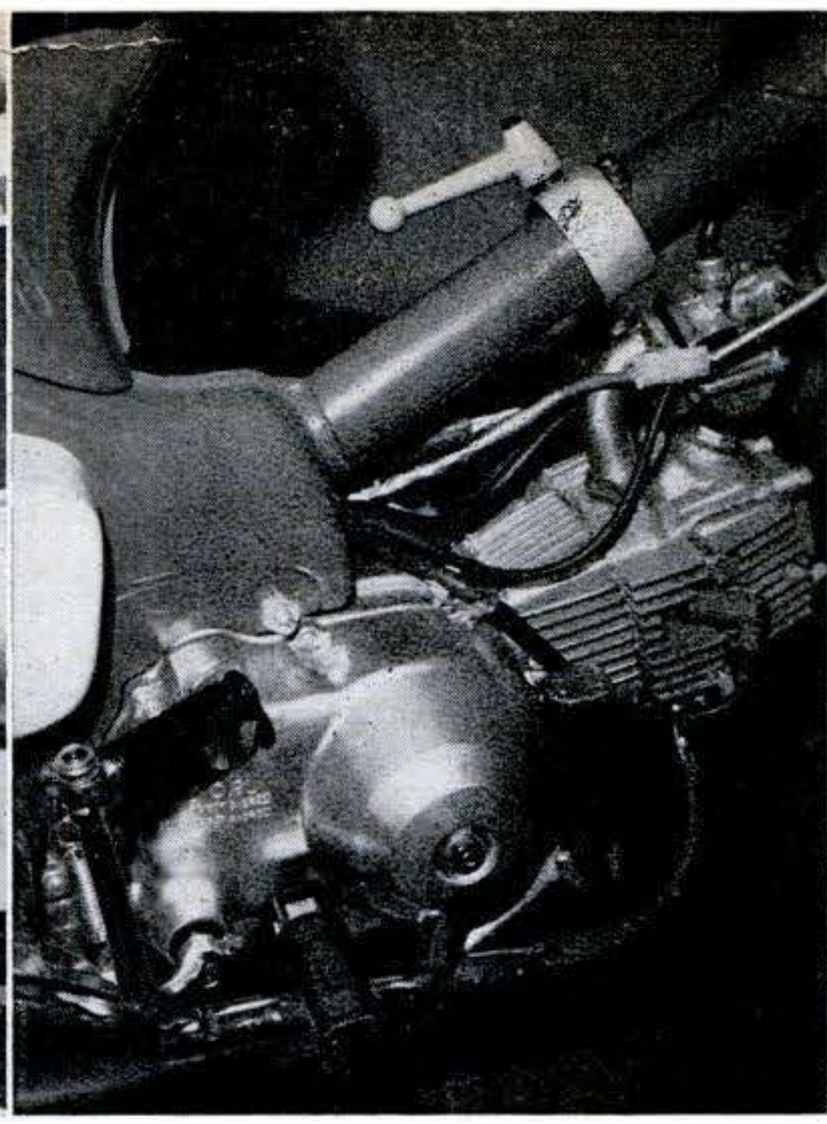
For private planes, breakdown bikes go easily through the usual small doors.



You disconnect the entire electrical system by means of a simple pull-apart connector.

Twist this handle and the frame separates. Modified frame is stronger than original.

with This Cycle in a Suitcase

about a minute longer. To achieve these quick-change capabilities, S & K added 90 new parts and modified 12 others.

These Hondas not only tear down quickly, they reduce into very small units. Without cases they will fit through openings as small as 12½ inches by 21 inches. This allows storage in small aircraft baggage compartments like those on the Cessna 172 and 182. Detachable handlebars, folding foot pegs and brake levers, modified gas tanks, and quick-release seat brackets make such compression possible. None of these modifications weakens the bikes or adversely affects their handling characteristic.

Prices start at $398, from S & K Air Sea Cycles, 1257 South La Brea, Inglewood, Calif.—*Jim Davis.*

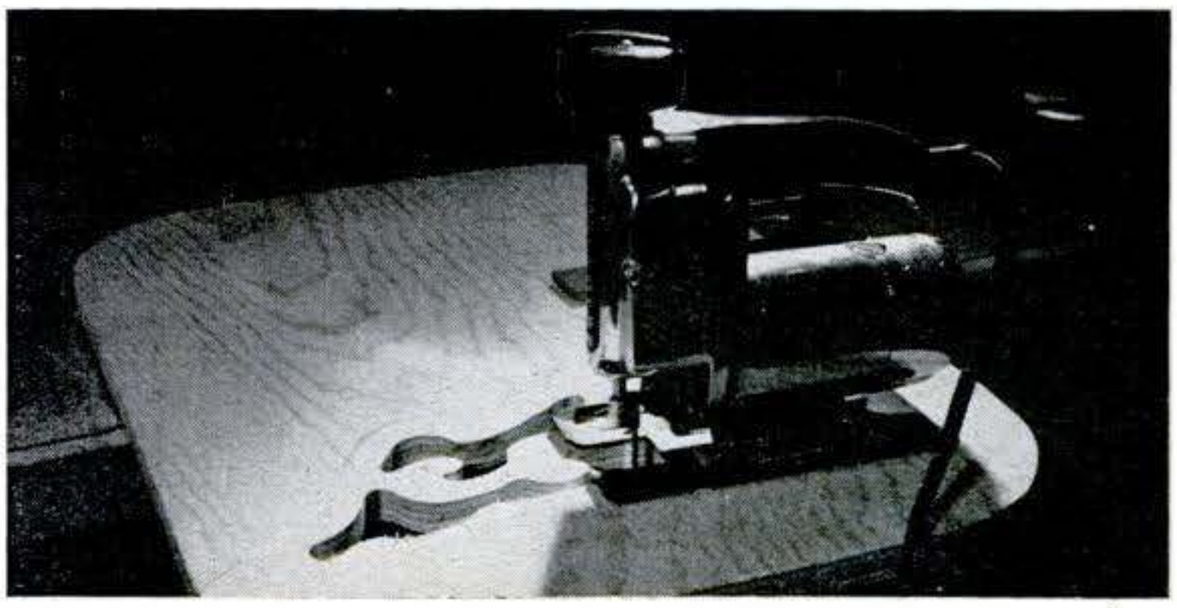
From Bolex: a "screen gem"

The most unusual feature of the new Bolex 7.5 Macrozoom Super 8 camera is its 7.5-21mm f1.9 lens, based on a unique, prize-winning design. With the "pocketable" 7.5, you can focus from infinity down to five inches without attachments, filling the frame with a butterfly, if that's your pleasure. You can also make titles directly in the camera and shoot special effects with a gadget that's included in the basic price of $189.50. But what really sold me was the superb feel of this slim, trim, delight—hand-held closeups are a cinch. (The Bolex Minipod, below right, let me work close to the ground without strain.) One small complaint: The trigger and focusing wheel are so close together that it's hard to focus while shooting, making me wish my fingers were as miniaturized as the Bolex.—*Arthur Fisher.*

The saw with a self-steering blade

Intricate cuts and awkward sawing chores yield easily to the magic touch of this new Craftsman Auto Scroller Sabre Saw. It's an improved version of the multispeed, steering scroll saw from Sears that PS reported on in detail in February, 1969. The big difference: The blade in this new tool steers itself!

I used the Auto Scroller on everything from cardboard to ¼" steel and two-inch lumber. It works as slick as a greased grape. The design is based on the elegantly simple idea of the caster—the vertical pivot center is placed ahead of the line of contact of the saw blade. A slight urging causes the blade to align automatically on the line of cut, regardless of the orientation of the tool as a whole. You can also steer the blade with the knob on top, or lock it rigidly.—*Hubert Luckett.*



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The Case of the Agile ATVs

Hop in with the world-famous creator of Perry Mason for an unforgettable adventure with all-terrain vehicles in the California back country

By
ERLE STANLEY GARDNER

PHOTOS BY JIM DAVIS

Popular Science's *noted consulting editor, Erle Stanley Gardner (left), greets Bill Iverson at start of ATV junket.*

I call them fun buggies, these go-anywhere vehicles that slither through swamps, even go right into lakes and become boats. They roll over rough terrain like little army tanks, and they can climb steep slopes. Out in the desert they scramble through deep sand and scurry up narrow canyons, squeezing agilely in between huge rock walls.

Some of these all-terrain vehicles (or ATVs) roll on wheels, others crawl on tracks. They're great for duck hunting, when you have to slosh through muck and water to reach choice blinds.

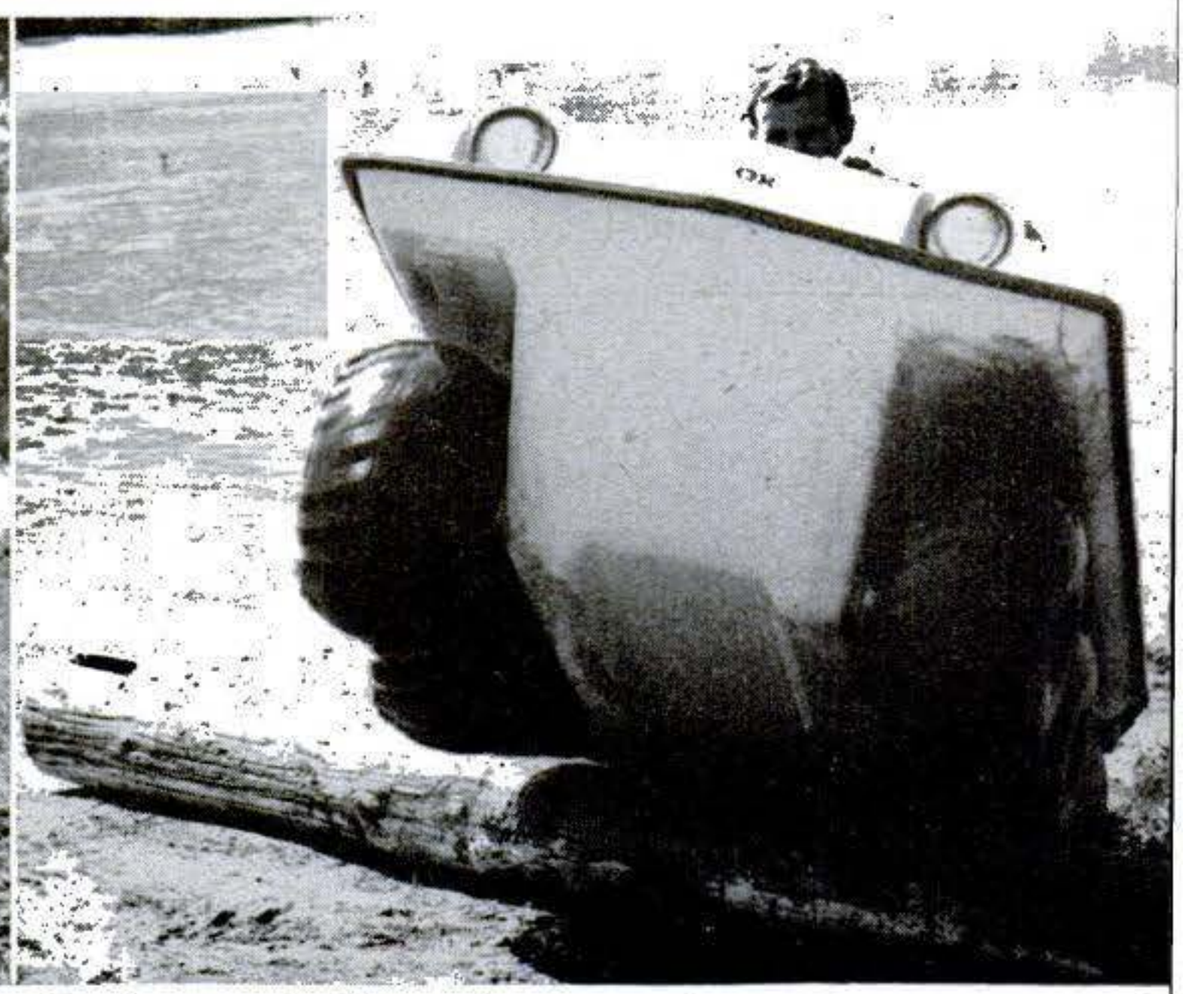
They are small enough to be easily covered with a camouflaged tarp. Yet they have a big carrying capacity; they can transport a couple of hunters with all their gear, including lunch, and bring back the game birds, too, when the day is done.

When I saw the last article on go-anywhere vehicles ["What Kind of ATV Is Best for You?" PS, Sept.], I asked Ernie Heyn, Editor-in-Chief, if we couldn't get some of these vehicles together for a fun trip. One thing led to another and Ernie Heyn asked his West Coast Editor, Jim Davis, to come down to my Southern California ranch for a mobile picnic to see what some representative ATVs could do for an outdoorsman in the wide-open western country.

Soon we had four ATVs—an Attex, Amphi Cat, Coot, and Pug, along with company drivers—gathered at my ranch. And we set out with these buggies for fun mixed with adventure.

We had an assortment of variegated but congenial personalities. J. W. Black and Bruce Barron had flown

The Pug carries five passengers and its driver almost effortlessly up a steep hill on the way to lunch in an oak grove on the Erle Stanley Gardner ranch at Temecula in Southern California.



Charging out of a lake in the Attex, John Rygiol runs into a mucky bog. But the nimble ATV can slither through without trouble. It's also able to negotiate rough terrain with equal facility.

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Amphi Cat (foreground) and Attex slosh around a lake at four m.p.h.—setting no speed records in the water. But it's fun.

ATVs demonstrate their maneuverability on the Rancho California where they helped to cut a herd of heifers. The Pug, Coot, Amphi Cat, and Attex (left to right) helped to corner the restless herd of about 100 cattle, racing after stragglers and matching their shiftiness all the way, staying on their tails until the heifers gave up and trotted meekly back into the herd

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The ATVs load and unload in minutes from their over-the-road trailers, ready to scoot away, like rabbits, on off-road adventures.

down from northern California to be with us. Black is a mechanical genius who designed all of the off-the-road vehicles that I use in Baja California —the Pak-Jak, the Burrito, the Butterfly, and the Grasshopper. That last is a dune buggy constructed on a VW chassis with lots of refinements.

Bruce Barron is an expert woodsman, camper, and airplane pilot. He's a man who can make wonderful music in camp, playing simultaneously on a guitar and a harmonica.

There was Sam Hicks, my right-hand man who can do anything in the outdoors. He has ridden rodeos, written a book of his own, is a publisher of a magazine, a photographer, and a cattleman.

David Hurtado, a Mexican who has been with me for years and has been through many adventures in Mexico and in Baja California, and Arturo Basquez, a rugged Indian who knows the country like a book, came, too. Arturo Basquez, who has been along on many a camping trip with us is, incidentally, a shrewd and skillful poker player.

Jim Davis, a man who thinks nothing of traveling across the continent on a motorcycle, was on the job. With him came Frank Berry, a motion-picture expert who has an encyclopedic knowledge of cameras.

Representatives of the companies that made the ATVs we were using made up the rest of the party.

Bill Iverson represented the Pug; Ron Burney, the Coot; Jerry Kirschner and Jerry Davis, the Amphi Cat; and John Rygiol, the Attex.

I knew these machines could do stunts. I knew they could climb steep mountain slopes. They could go over rough, rocky terrain—but could you use them just to have fun? That was what we were eager to find out.

Over the hills and far away. We began our jaunt over country that was not accessible to the ordinary car.

A neighbor of mine has a most interesting Indian rock, a huge, flat-topped granite boulder embedded in a mountainside where in prehistoric days Indians gathered to grind grain

John Rygiol takes off in an Attex with Arturo Basquez, an old Indian friend of Erle Stanley Gardner, who watches in background. The ancient oak tree in background has a spread of over 100 feet, and its lower branches reach down to touch their tips to the ground.

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Extra-low gearing enables the Coot to push its way through formidable rugged terrain.

"Uncle Erle" (right) examines the milling holes in ancient rock that was used by Indians for the grinding of grain and acorns. The ATVs took the Gardner party up to the site, easily climbing a steep hill to get there.

Even at slow speed the Amphi Cat can climb almost anything—within reason. The nimble ATV throws its front tires in the air, while the rear and middle sets keep it firmly on the ground as it negotiates the crest.

Long-abandoned stagecoach station makes a backdrop for Erle Stanley Gardner and his rig. Adobe building, pocked with bullet holes, was one of interesting sites visited by the ATV party. Below, putting the Pug through its paces in California desert are J. W. Black (left) and Bruce Barron.

and acorns. It is now on a dry mountainside, but probably in those prehistoric times there was a spring somewhere nearby. There are about 40 grinding holes in the rock. Some of them, perhaps used by newlyweds, are rather shallow; some of them represent years of hard usage and are quite deep.

It is possible to get up to the rock by tractor or by four-wheel-drive automobile, but the way our little fun buggies went scooting up that hill and then climbed right up on the rock itself was a revelation.

When we came back down, a couple of wide-eyed youngsters, children of the ranch owner, looked at the vehicles as any such tykes would look at something out of fairyland. So the drivers bundled them into the seats and proceeded to do things to demonstrate the flexibility of the vehicles, things that were completely incredible.

And how they handle! They would go 15 or 20 mph and then either make a right-angle turn or completely reverse themselves *right now!*

The popeyed children, hanging on for dear life, grinning from ear to ear, had the time of their lives. And these drivers could certainly handle their machines!

They'd come charging forward at a rapid rate, whirl abruptly, sending up a cloud of dust, then come to an immediate stop, parking within inches of the next rig. This raised the question of what would happen if we used them for cutting out cattle.

To find out, we went over to the Rancho California to see my friend, Louis Roripaugh, who manages the cattle end of the ranch. We found him, and a couple of cowboys, trying to hold about 100 head of restless cattle in a fenced corner.

We asked Louis if he wanted some high-powered help.

He and the cowpunchers took one look at the vehicles and shook their heads, but we rode into the lot anyway, and the boys picked up a couple of stragglers down at the far end of the 40-acre field.

The way those vehicles chased the stragglers was an interesting exhibition of maneuverability and driving skill.

These were heifers, fast on their feet and quite skittish. Whenever they thought they had a chance they would whirl and put on speed. But the vehicles were right on their tails, until finally the heifers gave up and trotted meekly back to the rest of the herd. Then our ATVs spread out so that we could help the cowboys "hold" the herd.

It was interesting to see these cowboys, their worn leather chaps flapping, come over to incredulously inspect these little machines that weren't much bigger than a minute, yet were capable of such remarkable performance—even as cowpokes.

Later we returned to my ranch, past some gigantic oak trees with a spread of over 100 feet and huge limbs

[*Continued on page 148*]

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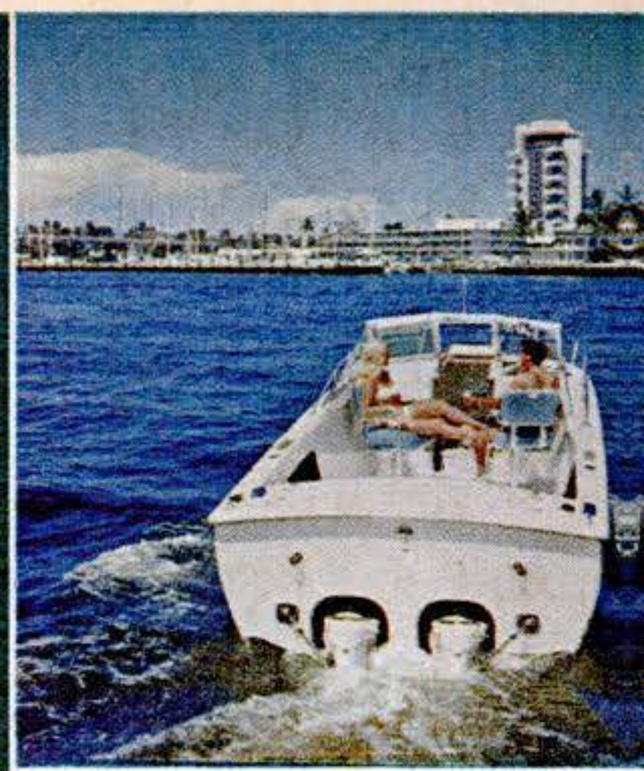

Twin OMC outdrives propel the new Sea Bird toward shore. It has high freeboard, gentle ride.

1970 FAMILY BOATS

Glastron's new model 166 has space for the whole family. This roomy runabout has two popular features: a bow-riding passenger compartment and walk-through windshield. It's Mercury-powered.

Boston Whaler, compact and sturdy, carries a whole family—even the dog. Great for fishing.

BOATING 1970

What's Your Thing?

PS Boating Editor Jim Roe presents a variety of new craft to suit every taste

Freedom of expression—that's the style today. And one pleasant way to express yourself is by doing your own thing on the water. Whether your thoughts turn to relaxation, action, girls in bikinis, or just fresh air and blue water, you'll find plenty to look at in these four photo-packed pages of marine temptations for an exciting 1970 boating season.

1970 HOUSEBOATS

Big new River Queen has all the comforts of home. Steel-hulled, this boat has speed, strength, and lots of room inside and out.

Newest Boatel is a cruiser-hulled houseboat with good seagoing ability. Up forward: flying bridge, wheelhouse, cabin.

New Nauta Line has a fiberglass hull, full cruising and living accommodations for a big family or several vacationing couples.

l Jet boat! Berkeley pump sends Glastron's V V-174 flying. Propless drive is handy in shallow water, safer for nearby swimmers.

New Slickcraft has a family-style layout driven by 115 Evinrude horses. Skiers and divers can use the roomy after cockpit.

A sharp-prowed Starcraft nuzzles up to the bank. Wraparound windshield helps streamline it; deck has storage space underneath.

D Crestliner's new Muskie 17 has a spacious d bow-riding compartment and walk-through v windshield. Hull shape gives it a soft ride.

Larson Volero, a racy 21-foot family runabout, skims over the waves with power supplied by a MerCruiser stern drive.

The Gypsy is new from MFG. Virtually every inch of this bow-rider is available for use as a family cruiser or sport boat.

Hopped-up horsepower: Chrysler's big 135-hp. outboard sports two racing stacks that boost output. This new limited-production mill has been making a name on the outboard-racing circuit.

A Carlson flies through the air—as will almost any 16½-footer when there's a powerful 135-horse Mercury outboard behind it.

Critchfield racing hull, also powered by a Mercury 1350, skips over the waves. This combination is good for over 45 m.p.h.

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1970 DAY CRUISERS

Chrysler's new Carvel measures 20 feet in length, is powered by a 120-hp. outboard, and provides you with a forward cabin for occasional overnight cruising.

New Larson Raider, a 23-footer with stern-drive power, has covered living space up forward and a large cockpit for sunbathers and sightseers.

Crestliner's new Norseman is another outboard-engine-powered day cruiser. What makes this type of boat so popular is its ability to ride hundreds of highway miles on a trailer, yet carry live-aboard conveniences for cruising.

This is the Cobia, a stern-drive daycruiser with spacious forward cabin, an even more spacious after cockpit. Folding canvas top can be added over cockpit; bow rails are another option.

Sea Bird daycruiser comes with berths in the cabin under bow deck, and fold-down seats for sunning or sleeping in cockpit. Soft-riding hull, high freeboard make it a good family cruiser.

1970 CANOES

Starcraft's aluminum canoe features built-in flotation in the bow, a square stern for attaching an outboard—if you'd rather not paddle. With 1½-hp. engine like this Johnson, it's a lightweight rig.

Aerocraft's canoe, designed for wilderness use, is easy to portage. Aluminum hull is woodgrained outside for a rustic appearance, all white inside to reflect the sun's rays and keep the metal skin cool.

1970 STRICTLY FUN

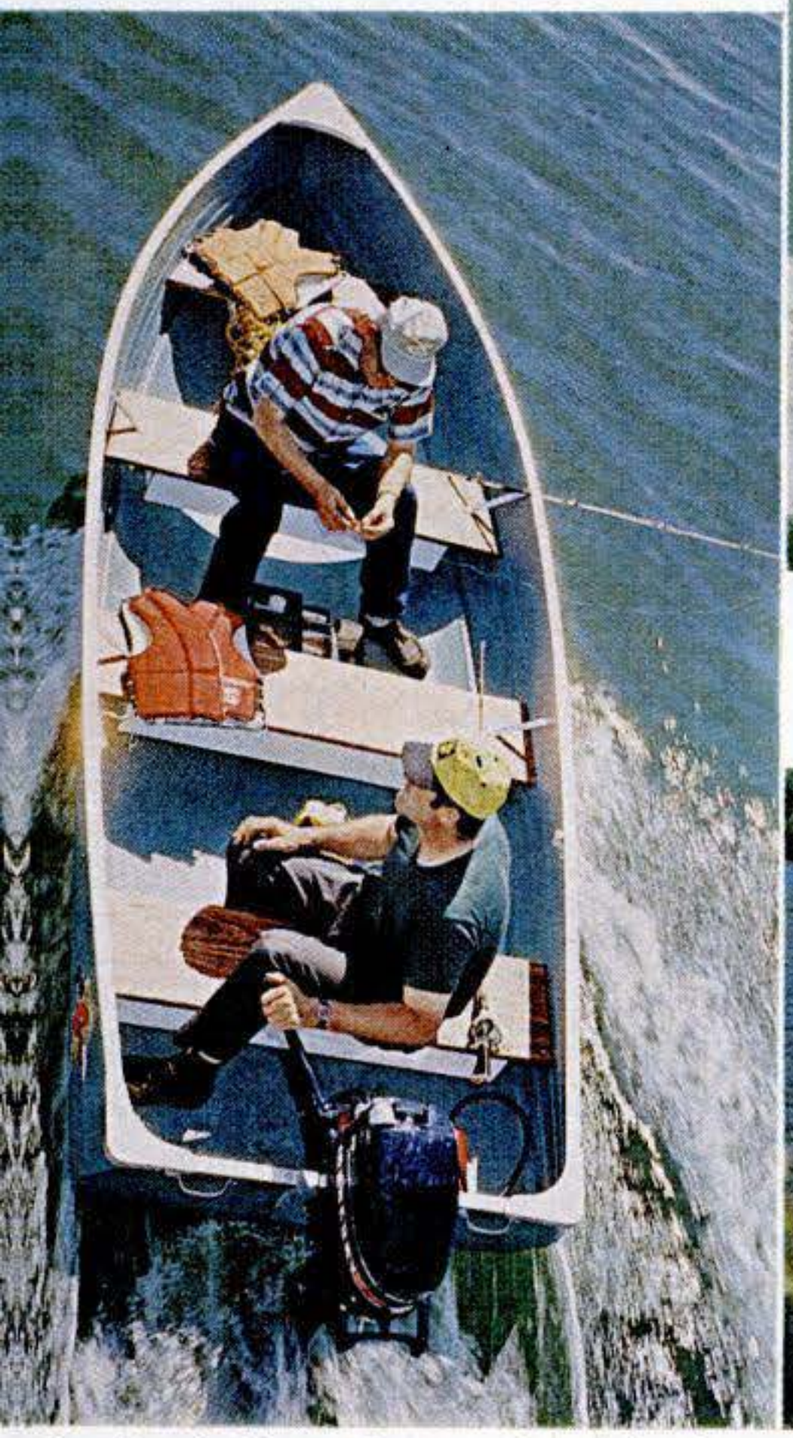
Skimmer-type craft of fiberglass is a one-passenger fun boat powered by a small outboard. A Johnson motor propels this one.

Glastron's popular party platform hosts a bevy of sportsmen and spectators. Versatile craft is self-propelled and roomy.

Johnson's Front Runner is rigged here for family camping. With canvas top down, the OMC stern drive makes it a fast ski boat.

Called Man O'War by Chrysler, this 15-foot sailboat was made for easy car-topping. Drive to the nearest water and drop it in.

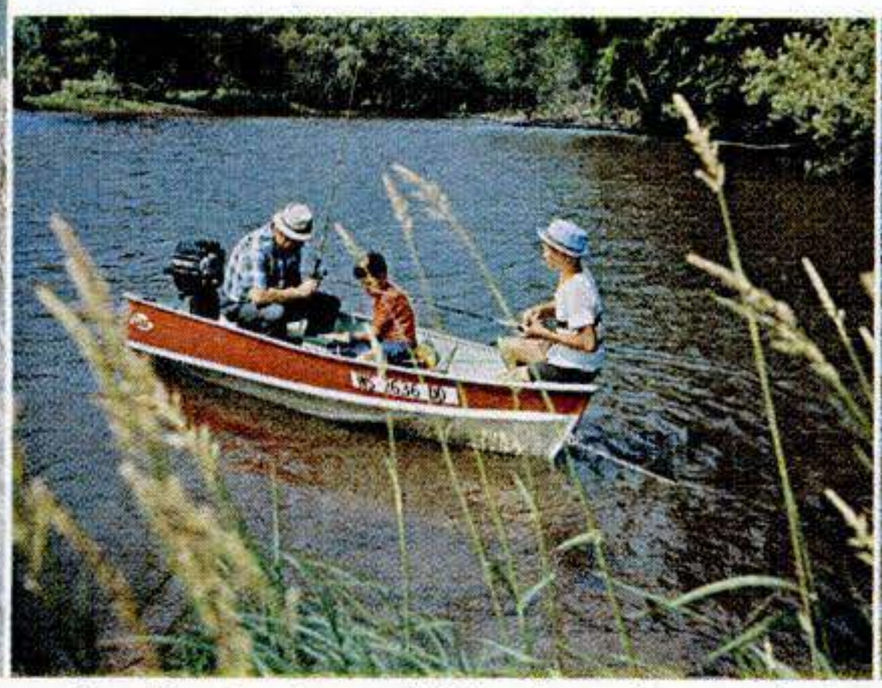
1970 FISHERMEN



Crestliner's Super Seaman is an aluminum fisherman. Four seats hold a boatful; flotation under three makes boat unsinkable.

New 23-foot Winner sports a flying bridge and deep-sea fishing poles. This speedy fisherman was designed for offshore waters.

Kayot's party boat, a platform on pontoons, has enough rail space for your entire local Elks Club to fish. It's outboard-powered.



Lund's aluminum fishing boat is a typical car-topper. Lightweight and easy to handle, it zips along nicely with a 7½-hp. outboard.

Cruisers, Inc., convertible runabout of fiberglass holds these—ah—fishermen. Extra little Johnson outboard is for trolling.

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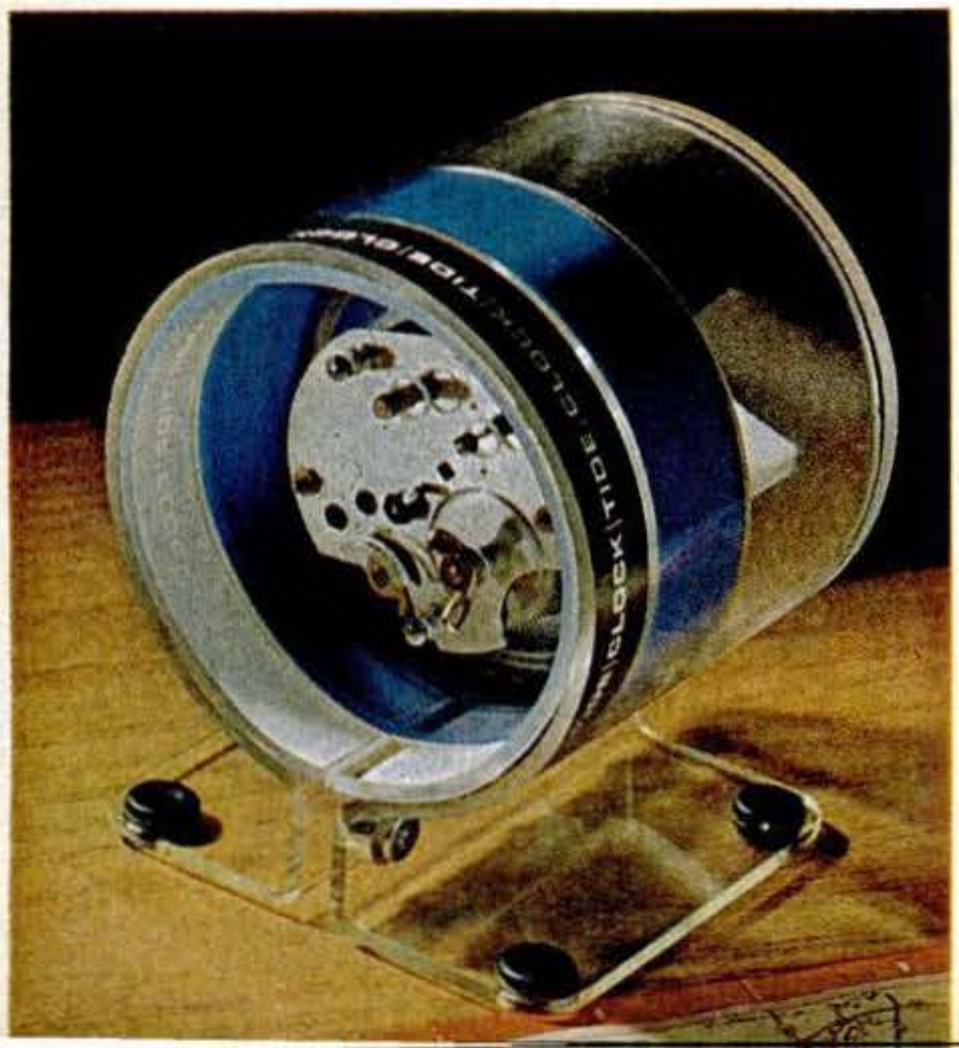
A GREAT CONVERSATION PIECE...



A Clock That Tells the Tides

You take the works from a windup, slow them down to match the tides, and install them in a plastic case. For details of this challenging project, please turn to page 136

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What Fun Boating People Have!

By DAVID D. VIGREN

When you launch a new boat, naturally you have to explore the rig's capabilities, and with equal care explore the shorelines, rocks and shoals, and currents in your local waters. This can be engrossing—puttering around on the water—and you may never get over doing just that.

But out there you immediately see all the other things boating people are up to. Jack Jones used to disappear from the dock around the bend and you wondered what kept him out on the water all day long. Now you know. He fishes the shorelines, stopping every few hundred feet to cast, and sometimes to play a good fish. Looks like great fun—and is.

Gain real competence in handling your boat and you're ready to learn to tow the water skiers in your family. And some boaters take up rather serious things: scientific navigation, weather forecasting, or observing marine life with the help of scuba gear.

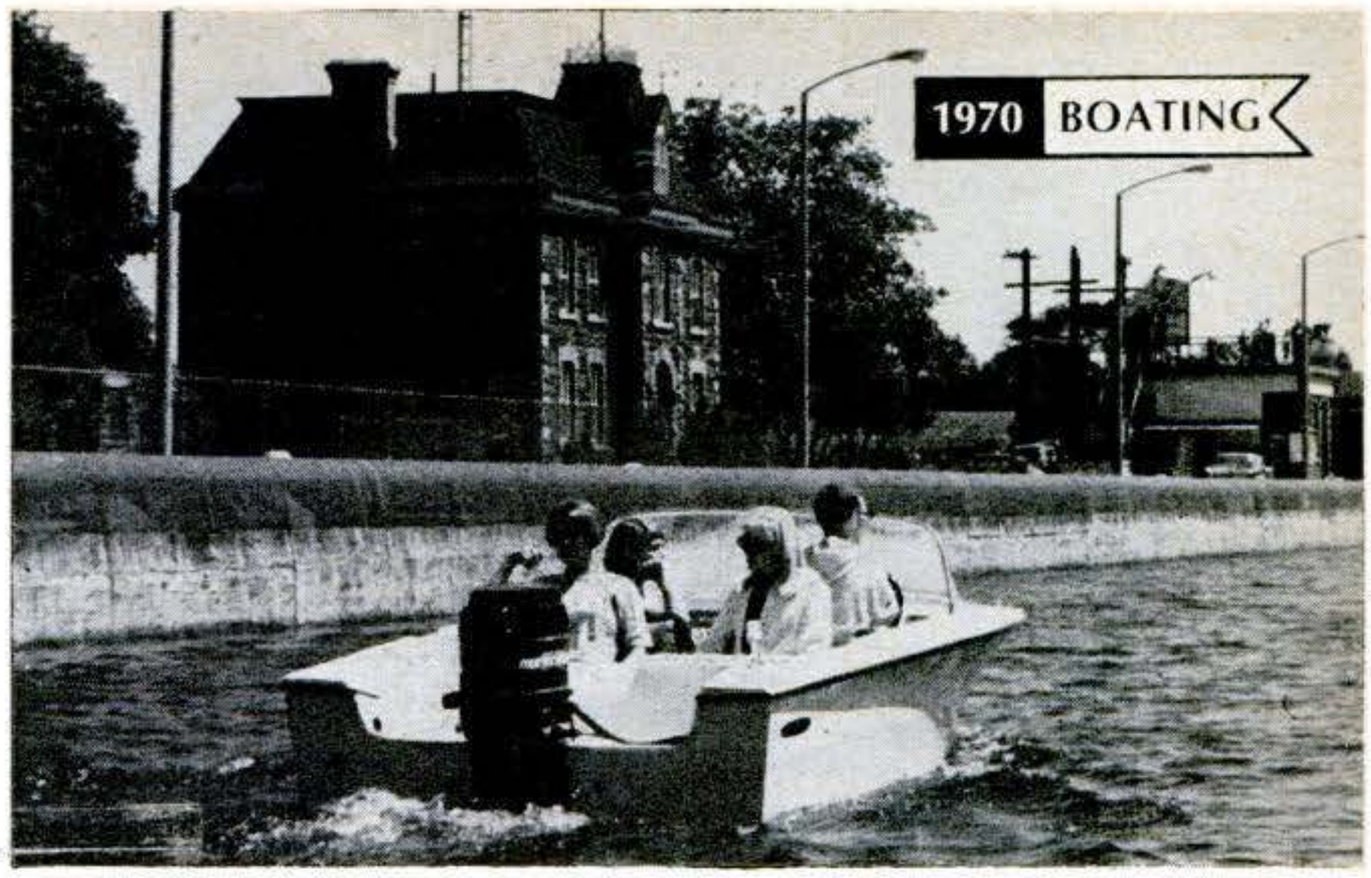
Soon you are ready for your first cruise in your new boat. You're the captain, so you figue where service stops are enroute, what gear and supplies to take along. You know how to navigate and plot your course. Then don't forget to enjoy the cruise. Splendid water trips of a day's or a month's duration can be enjoyed in a sound boat; the craft doesn't have to be either big or expensive—just suited to the water you're on.

Trailer to Shangri-La. Trailering can extend your boating range to Alaska, the Florida Keys, or Newfoundland, as you choose. Ask at your gas station about the cruise-information guides that several oil companies issue. They're excellent for the major waterways around the U.S.

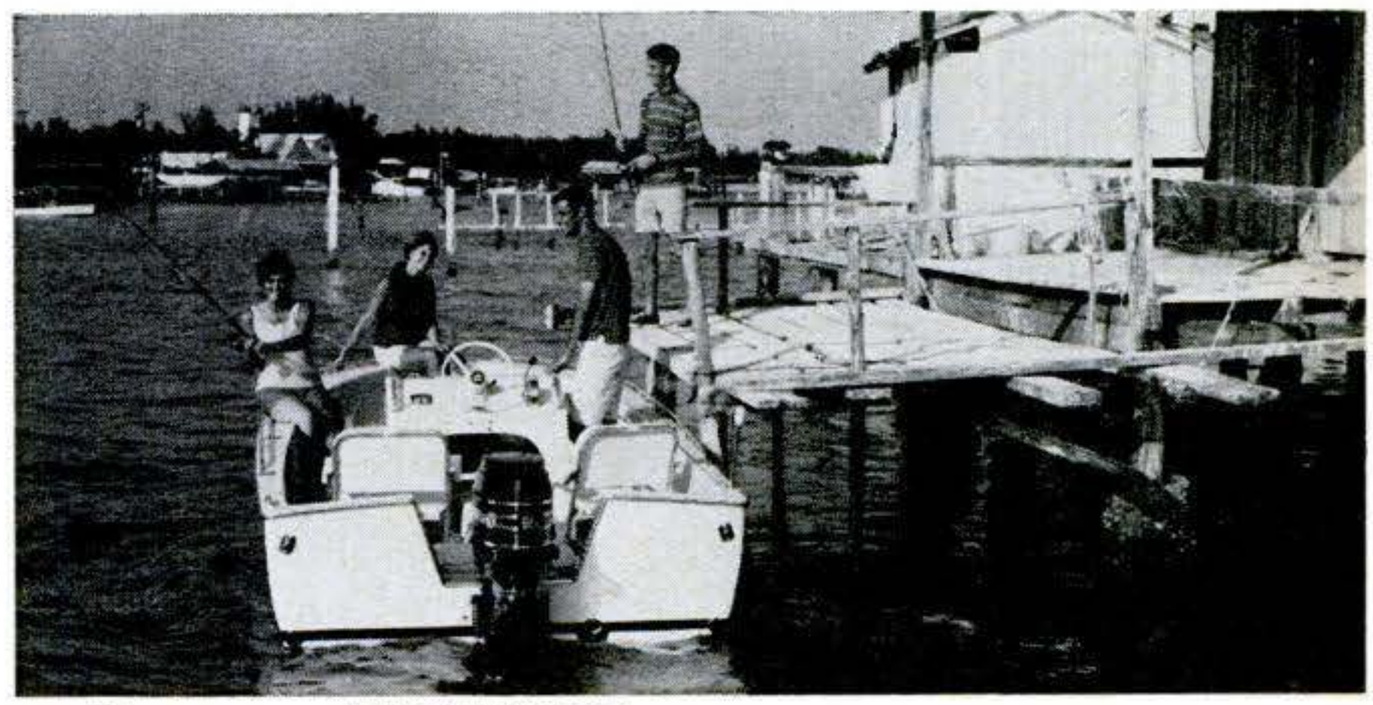
Now that you've got your boat well wetted down, you can even think about becoming a two-boat owner. A canoe, easy to sling on top of the car, lets you enjoy the smaller rivers and streams where a powered boat can't go. The Delaware River through New York and Pennsylvania, the Ozark Rivers of Missouri and Arkansas, the Big Fork River flowing north to Minnesota's international boundary are good examples of streams in every region where you can drift-cruise in idyllic surroundings.

When should you join a boat club? When your boatsmanship and rig are as complete as the Smiths'? Naw. The best time to join is when you're brand-new on the water. It's the safest and quickest way I know to learn all-around

[Continued on page 142]



—they go CRUISING



—they go FISHING

—they go on CANOE TREKS

—they EXPLORE UNDERWATER

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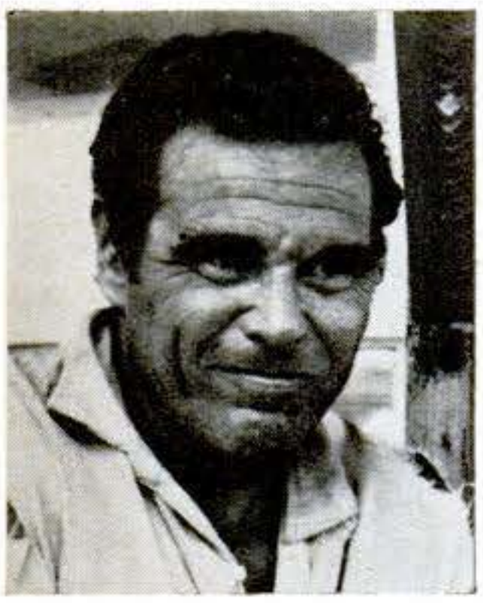
From My Ocean Racers: a Better Boat for You

The world's ocean powerboat champion reveals how he develops 80-mph racers that can add mph to your boat, too



By DON ARONOW as told to WILLIAM B. HARTLEY

Don Aronow has twice won the world ocean-racing championship—in 1967, and again last year. A powerful man, 200 pounds and over six feet tall, Aronow retired at 30 from a lucrative construction business. Since then he has developed and sold three successful boat designs—Formula, Donzi, and Magnum.

I race to win, design to win, develop equipment to win races. Then I pass along the knowledge of what my associates and I have developed, because I believe a good ocean racing boat makes an excellent boat for wider pleasure use.

The recreational boater is now receiving perhaps 25 percent more efficiency through the development of our designs and ocean racing in general. And boats may now be lighter, stronger, and softer riding than they were five or six years ago.

When I moved to Miami in 1961, I decided to run in the Miami-Nassau race. The Bertram deep-V fiberglass boats had racked up a number of wins, and boat racers were growing aware that this hull design was the most promising for ocean racing. These deep-Vs were faster in rough water, and easier on men and equipment.

Knowing very little about race boats, I had one built—a conventional wooden hull with a modified V. We came in fourth, and I found that the boat wasn't capable of running in rough water with competitive Bertrams. Because of the flattened bottom surface, she would hit very hard—destroying our equipment, hull, and ourselves in the process. More important, we were losing.

My associates and I knew we would have to shift to fiberglass, and also design a boat that was narrower and had a much finer entry than the existing deep Vs. The result, after about 18 months of experimentation with a 27-foot formula, was the Formula 233 which had a 3:1 length-to-beam ratio—a centerline length of slightly over 23 feet with an eight-foot beam. The Formula 233 was a great race boat, and was (and is) a fine recreational boat.

Slimmer boats for more speed. We are now moving toward a ratio of 4:1—longer, narrower boats with fine entries. The Cigarette, which has been so successful in 1969 and has won more races than any other boat in ocean-racing history, is 33 feet long with a nine-foot beam, or very close to a 3½:1 ratio.

We have to be careful about fine entries, however. If you go too fine, or narrow in the bow, when the V enters the water the boat may dip in too fast, or "hunt," which means it veers to port or starboard, depending on how it re-entered the water.

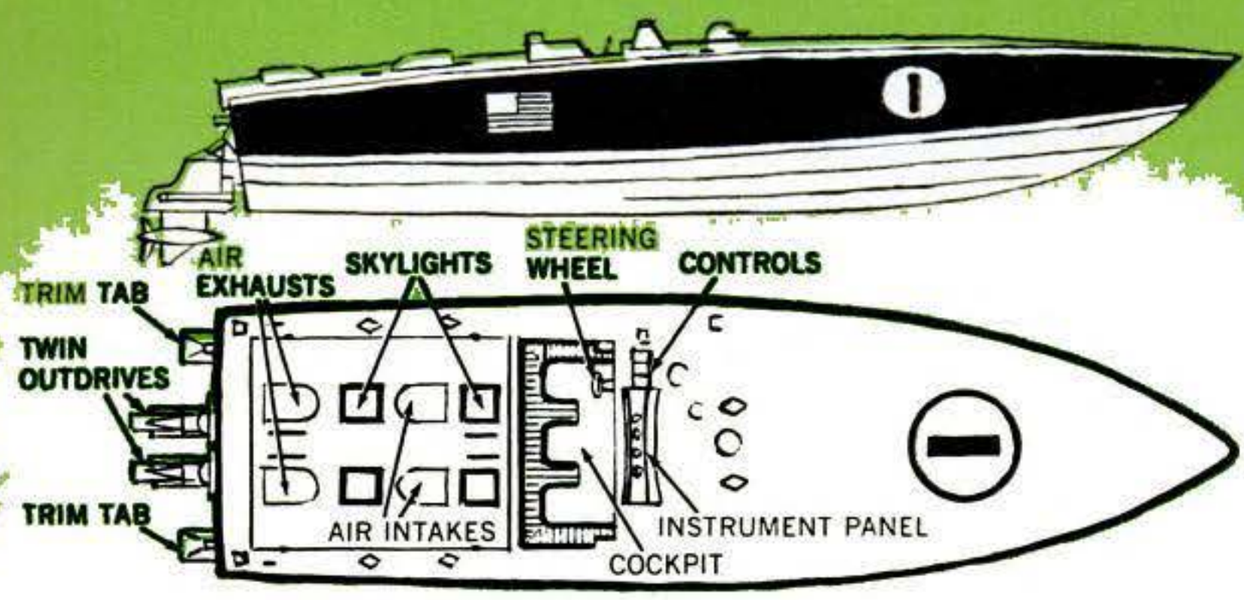
The original deep-V boats had a somewhat full entry forward that would cause the boat to float, or lift back up quickly when re-entering the water, and pound heavily.

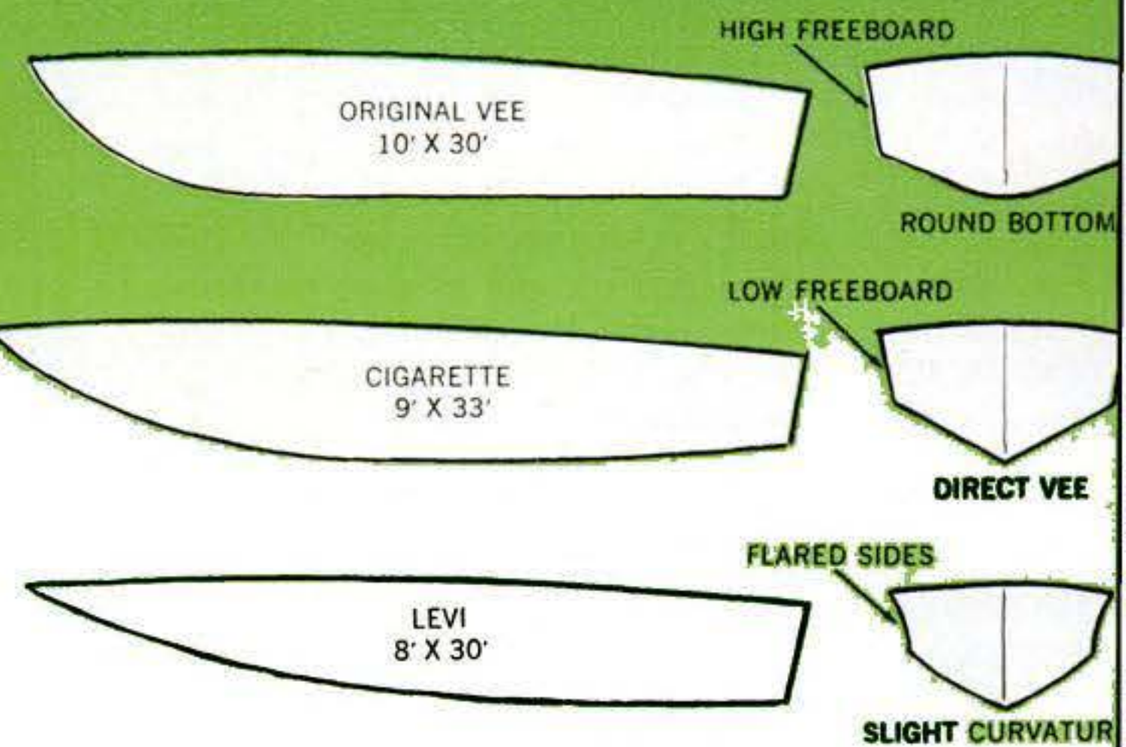
Renato Levi, working in Italy, developed a longer, narrower boat with little support up forward. This was quite fast in calm and medium seas, but not the most desirable for rough water.

The original Vs had rounded bottoms. The Levi bottoms have a moderate curvature, while ours are closer to a true or direct V. The stem profile was originally inclined toward the perpendicular. Ours, as in the Cigarette, now has a long sweep.

Design factors interrelate. In design, of course, everything relates to everything else. For example, the main thing strakes do on the bottom of a boat is to deflect water and give you a lift where you want it, thereby reducing the wetted surface at high speed. Theoretically, if only the propellers were in the water and the hull never

Aronow illustrates some fine points





Cigarette's light fiberglass skin is ribbed throughout with ½-inch plywood. She's powered by two 475-hp. Mercruiser Outdrives. Two cylindrical aluminum gas tanks forward of the cockpit, and four aft, hold 372 gallons. Dry weight is 8,000 pounds.

Ocean racing has bred sharper prows. First deep V (top) had a full entry, almost vertical profile, 3:1 length-to-beam ratio. Levi design (bottom)—fine entry, long sweep, 4:1—is other extreme. Cigarette compromised for rough-water speed.

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Aronow's present ocean racer was named for a prohibition-day rum runner. It holds the ocean racing speed mark of 74 mph.

touched, we would have a spectacular racing boat.

Width, angle, and *location* of the strakes are important, and you also have to make certain they don't produce air bubbles (cavitation) around the propellers. These vapor pockets would cause them to lose efficiency.

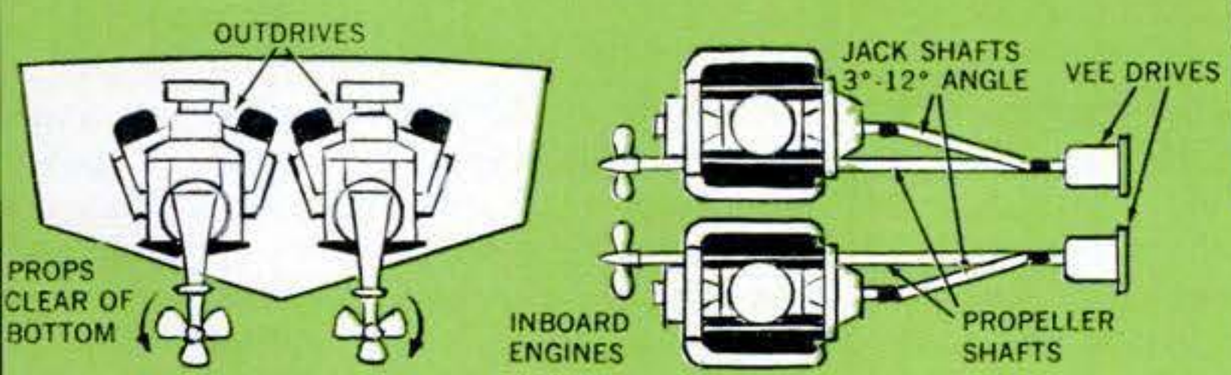
The positioning of weight is tremendously important in a deep-V boat. For speed, you want your weight aft; but too much will make the boat slosh, with the transom coming into the water too soon before the bow. The idea is to keep the weight aft constant. When you put your engines aft, you know the weight is always stationary. (This wouldn't be the case if the gas tanks alone were aft.)

I can't very well tell you, "Strakes should be in such-and-such a position, and engines of this particular weight should be located blank feet and inches aft." Many variables enter the picture. What we do is to design and experiment with each boat toward the most satisfactory conclusion.

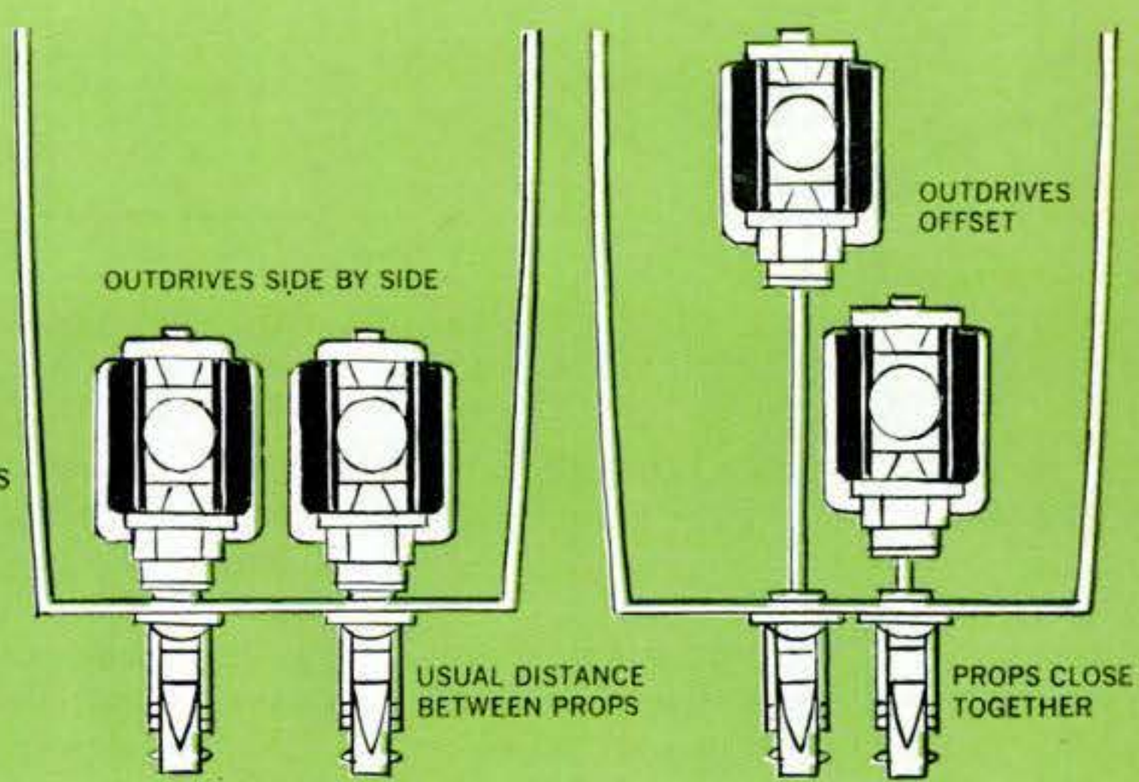
Rocker or hook? A few words, however, on rocker and hook (or wedge) *on the bottom of a boat* where it meets the transom: A boat designed for V or direct drive can have some rocker built into the bottom, but you have to be careful. Built-in rocker tends to thrust the bow up, and the boat may have a tendency to porpoise, with the bow going up and down. You can use rocker in a boat for V drives or direct drives provided the weight is correctly proportioned and the rocker developed properly. Too much weight in the after end of a boat will also make it porpoise.

A wedge or hook, on the other hand, tends to put the bow down. In out-drive boats of the kind I use, it's very important (and people are just discovering this) that the bottom of the boat be perfectly straight, without rocker

You tip the bow up or down with built-in rocker or wedge. Inboards often use some rocker to thrust the bow up. Outdrives need a straight bottom, use trim tabs as an adjustable wedge.



Twin outdrives perform best in rough water when close together; both props turn outboard. Aronow likes outdrives because props are astern of the transom, perpendicular to the bottom.



Outdrives on the Cigarette (right) are staggered. This puts props closer together and deeper in the water—so they stay in longer when the boat bounces. Conventional setup is at left.

or hook. It must also be rigid. Our trim tabs, which I'll discuss presently, serve as an "adjustable hook."

How much power? The layman is apt to think mistakenly that racing-boat speed depends solely on engine horsepower. But increased power doesn't necessarily mean greater speed or efficiency. Every boat we develop today is designed to relate to its power, and vice versa. For stock boats used by the public, it should be the same.

I've known boat builders to take a boat designed for a certain use and speed, underpower or overpower it, and thus make it an inefficient machine. There's no sense in getting a deep-V boat like ours and putting in too little power; the boat won't run properly. And little is gained by putting excessive power on a boat designed for fishing.

Successful racing calls for attention to every imaginable detail. For racing, it's best to have the propellers back as far as possible. That's one reason the outdrive is so great; the propellers are well astern of the transom, whereas in standard inboard boats the props are under the boat and forward of the rudders. With outdrives, we eliminate rudders, struts, shafts, and also have a propeller that has no "shaft angle." (Theoretically, a boat runs more efficiently when the propeller hub is parallel with the boat's bottom.)

To reduce weight, we build our racing boats with as thin a fiberglass skin as possible. We keep reducing the weight on succeeding hulls until we "break up" the boat. As soon as we reach that point, we reverse. Expensive, but that's racing!

In our production for recreational use, the weight and thickness is about 1½ times what it would be in our racing boats. This assures us that the public will have no problems with the fiberglass.

We find that if fiberglass boats are not built properly they'll develop "waviness." This waviness is the first thing a buyer should look for in a quality boat. If you detect it on the sides and especially the bottom, you know that either the molds for the boat are poor, the boat is reinforced improperly, or the fiberglass wasn't cured correctly.

At the speeds we're attaining now—around 80 mph in 32-footers—we have to bring in aircraft designers to help us design decks for maximum speed, to increase or reduce lift in the bow as the boat requires.

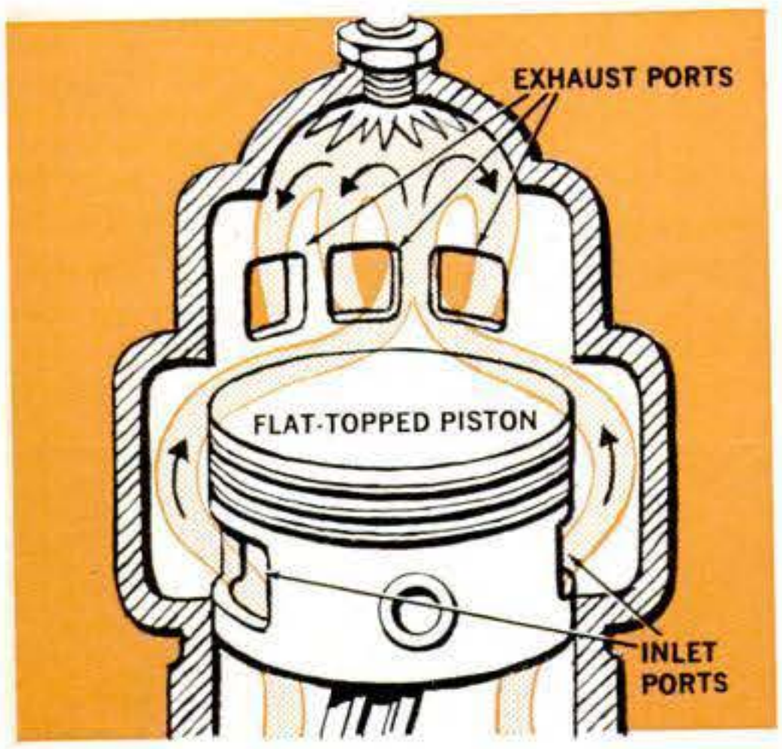
Engines are slimmer. Engines are designed differently today because of situations we have encountered in ocean racing. Engine manufacturers have become aware that we want propellers as close together as possible for maximum speed in rough water. Thus they have slimmed the width of engines, which also saves space in a stock boat with direct drive. I believe that engine and equipment manufacturers have found out, as we have, that what's good for ocean racers is also good for the recreational boater.

When we put a pair of engines in a boat, we try to mount them as close together as possible, because we can run our jack shafts to our V drives on a three- to 12-degree angle.

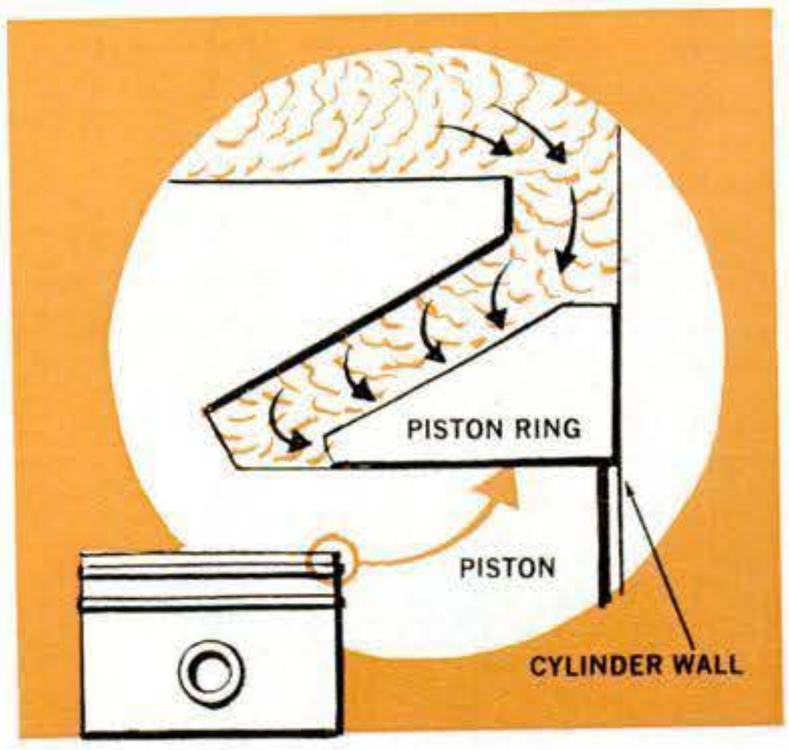
On stock outdrive boats, the distance between the outdrives is limited to the distance between engines. In racing boats, we get our outdrives even closer together by staggering the engines.

Propellers keep getting better. As a result of ocean racing, the materials in propellers are superior today. With

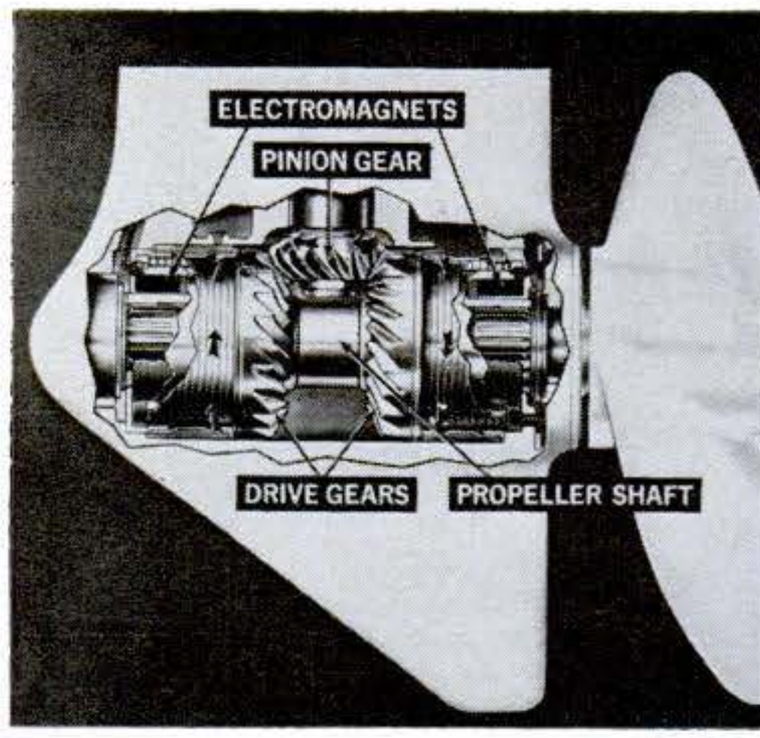
Inside the '70 Engines: New Feature



Loop-charging shoots a fresh charge into the combustion chamber of Johnson's two-stroke engine. Charge swirls up and over the piston, driving out the exhaust gases.



Combustion gases press this piston ring against the cylinder wall of an Evinrude engine, sealing the chamber during power strokes. Reduced blow-by boosts output.



To shift gears on OMC drives, energiz the forward or reverse electromagnet This anchors free end of a clutch sprin —wound around prop shaft—to the shaft

By **JIM ROE**/*PS Boating Editor*

Buried deep within today's outboards and stern drives are engineering gems you never see. So we've peeled back the coverings to reveal a few.

Loop-charged scavenging. Considered by Johnson engineers to be their achievement of the decade, loop charging sharply boosts the efficiency of two-stroke Sea Horses. Each fresh fuel charge shoots quickly into the combustion chamber and loops around, driving out spent gases.

With new port design comes a lighter, flat-topped piston and slimmer rings. The lighter weight, lower friction losses, and reduced ring flutter mean higher engine revs.

Pressure-backed piston ring. Gas inside the Evinrude's combustion chamber seals itself in during the powe stroke. Gas presses a wedge-shape piston ring against the cylinder wal more tightly than conventional sprin action could. The reduced blow-by ups power three percent. Varyin pressure twists the ring in its groove scraping carbon off.

Electromagnetic shift. Two electro magnets, controlled by a microswitch

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ofter, stay drier than boats of a few years ago

stainless steel, Nibral, and other alloys, we're close to having props that are hard as they can be without becoming brittle, fracturing, or rusting. We use engine governors or "cut-outs" to prevent rpms from going out of sight when an ocean racer leaps completely out of the water. With the terrific overspeeds in racing, you could bend shafts and twist prop blades when the boat lands, or blow up an engine.

Even though clutches are now greatly improved, further improvements are needed to handle more power. In the Cigarette, with two 475-hp engines, we use gearboxes.

Hull design and related power are, naturally, of primary importance in an ocean-racing boat—or a stock boat. But there are some other devices which, used together, make an appreciable difference in winning races.

I use Mercruiser outdrives for racing. Within the past few years, power trim has been added. This means that you can pivot the outdrives up and down. If you move them down underneath the boat in rough water, the blow will drop and you can maintain excellent speed on the level. If you move the outdrives away from the transom and up, you'll get even more speed. You also have the advantage of bringing the outdrives up by pressing a button to change a propeller with the boat in the water.

Tricks with trim tabs. We also use trim tabs—relatively small pivoting metal plates attached to the transom at right angles and raised or lowered into the water by electric, manual, or hydraulic power. They get the boat on plane faster and can control its running attitude.

Pushing both trim tabs down lowers the bow. We also use them for trimming in winds; you lower the tab on the side opposite the wind in order to keep the boat level.

Donzi 28, an early Aronow boat, set records in 1965 Miami-Nassau, Around Nassau Sweepstakes, hitting 70 mph with twin 427-cu.-in. Holman-Moody Ford engines rated at 500 horsepower each.

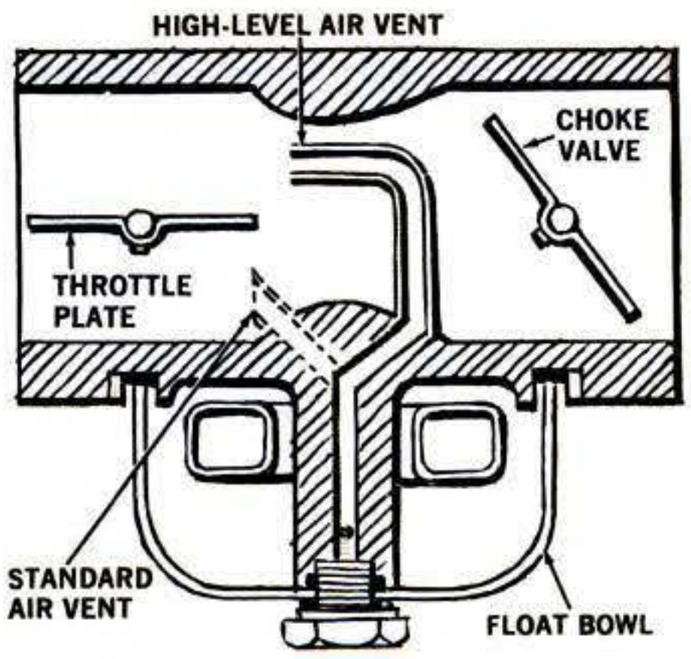
When you use trim tabs and power trim on the outdrives in combination, you can do some interesting things. In racing, we sometimes put the outdrives far out for speed and put the trim tabs down a little to stabilize the boat. Even in a stock boat, this is a great combination.

Ten years ago, I began to develop and use ballast tanks. I wouldn't recommend them for a weekend fisherman—only for the professional who runs in heavy seas over long distances. If properly used, ballast tanks greatly increase stability and speeds in head and cross seas.

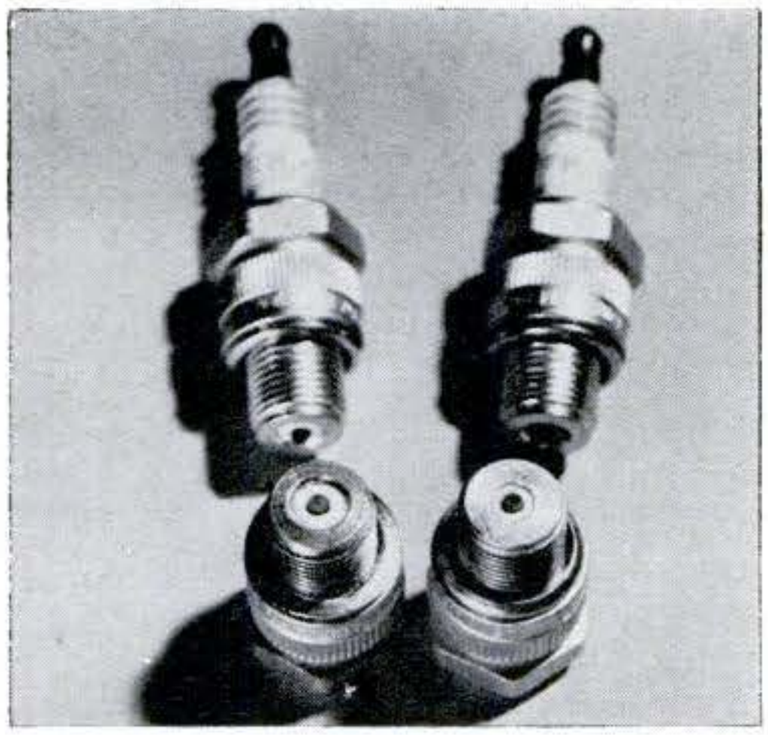
I believe that in the relatively near future we'll achieve speeds of more than 100 mph with turbine engines and catamaran hull structures. I don't expect these boats of the future to beat the deep Vs in rough water, but they'll be excellent in medium-to-calm seas.

And you can be sure that if they run well in ocean races, the recreational boater will have them soon after. PS

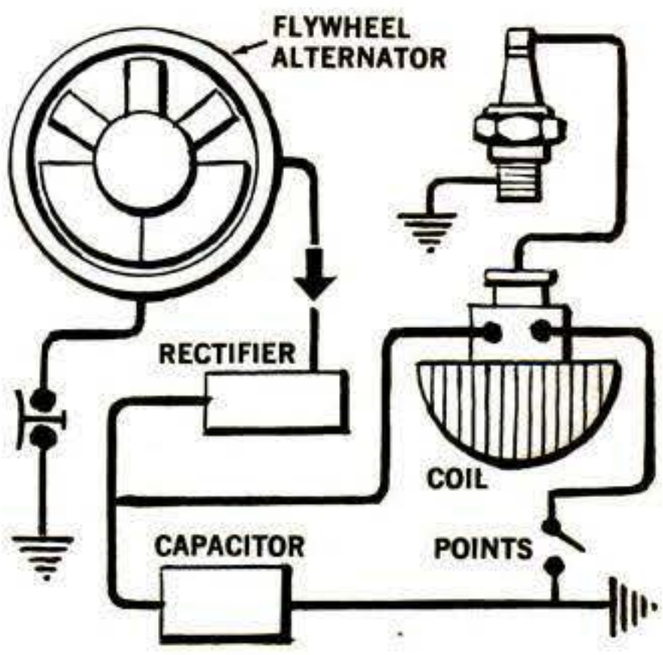
or Go and Durability



Long vent tube sticks up into the intake of Chrysler's carburetor. Unlike a short standard tube, this one won't dribble gas from float bowl if the engine's tipped.



Tough center electrodes on Perma-Gap plugs erode very little. For Mercs up to 20 hp., radial gap is .067 inch (left). For 40 hp. and over, it's .050 (right).



40,000 volts leap plug gaps in Mercury's Maker-Point ignition. Spark starts as AC, is rectified to DC, stored in capacitor, released through a coil when points close.

replace the older mechanical linkage in OMC stern drives. Smoother and quieter, the magnets pull forward or reverse gear into engagement against a clutch spring.

Dripless carbureter. Chrysler's new carbureter won't leak gas when it's tilted or laid down. Instead of the short float-bowl vent in most outboards, Chrysler has a long vent with a bend in it. Gas can't escape from the vent into the intake manifold and out of the engine.

Perma-Gap spark plugs. They last the life of your engine, say Mercury engineers. The surface-gap-type plugs have a tough center electrode that won't melt below 6,000 degrees F.

Maker-Point ignition. Companion to Perma-Gap plugs is Mercury's turnabout ignition system. Maker-Point fires the plugs when points close, instead of when they open. Result: no arcing to pit the points.

By-pass cooling. Fisher-Pierce has a new cooling system for its Bearcat, formerly the Homelite and still the only four-stroke outboard. While most of the cooling water warms up in the block, some cold water bypasses the thermostat to cool hot exhaust areas. When warm block coolant opens the thermostat, bypass closes.

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Hoist Sail for Family Fun—and

In hours, you can learn to sail —and join the fleet in this fastest-growing water sport

By BOB SMITH
PHOTOS BY SUE CUMMINGS

There you are, down on the water, feeling the power of the wind, absorbed in the challenge of how to use that power to best advantage. Maybe you're day-sailing with the family, skimming lightly, silently, over deep blue water to a hidden favorite beach or a cove. Or you're racing. You're fighting for third place. Astern is number four, coming up fast. Can you beat him? Those are some of the thrills of sailing.

It's a sport for the thinking man. The more you sail, the deeper you get into the scientific reasons behind your boat's behavior—and the better sailor you become. You needn't be an athlete, either. Kids of eight can sail, girls make excellent skippers, even men in their seventies are enjoying sailing.

Literally millions of people have discovered sailing in recent years. It's now the fastest-growing water sport, because it has become easier and less expensive to enjoy. Here's why:

- Fiberglass hulls require little maintenance, are easily repaired, and hold their resale value well.
- Trailers let you store the boat in your garage or yard rather than at a marina or yacht club. You can go sailing anywhere there's water. Many small boats can be car-topped.
- Places to sail and launch boats are multiplying. There is more shoreline inside the U.S. than around its edges, for example.
- Over 400 one-design sailboat classes are registered in this country today, and better ones keep coming along all the time.
- Class organizations and "paper yacht clubs" (clubs with no facilities) make it easy and inexpensive to join other sailors for group fun.

Joining the fun. Newcomers to the sport will tell you that any fears they had about sailing have turned out to be unfounded.

It's not a rich man's sport. You can buy a brand-new boat, complete, for as little as $700. Even a millionaire can't buy a better boat of that class. Many used boats, costing a few hundred, may sail as well as a new one.

The boats themselves are not dangerous. If capsized, you hang on to your boat until rescued. Small ones can even be righted, bailed out, and sailed away without help.

You don't have to be an expert to enjoy it. In one weekend you can learn the basics of sailing and start right in. Simple rules keep you from running into other boats. Sail as much or as little as you want; like chess, sailing can be enjoyed at any level.

Sailors are friendly people who welcome visitors into their yacht clubs, lend a hand to beginners and those in distress. Status comes from sailing well, not from how much you can afford to spend for a boat.

All of the sailboats pictured on these pages are day sailers. You can hop in any of them and shove off for an hour's or a day's sail by yourself. Most will carry at least two persons; some handle four or five.

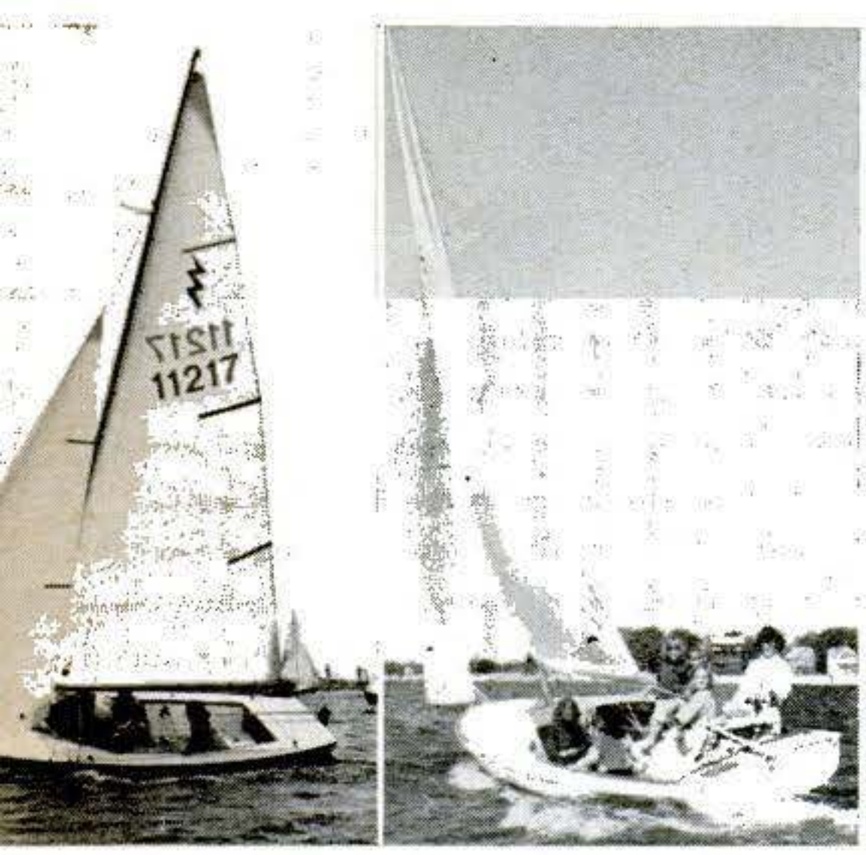
These are all registered one-design boats, too. Which means you can find others with identical boats to race against. Besides this bonus, you will find a class sailboat easier to learn about, buy, and sell.

How to get started. If I lived near the water, the first thing I'd do is drop in at the local yacht club. Any member can tell you what classes of boats are being raced in the area. The more knowledgeable men can help you decide which boats would suit you best. You can assume they're suitable for local waters if many people are sailing them there.

Here's some good advice to help you decide which boat to buy: Stick with a fiberglass boat; it's durable, easy to maintain and repair. Choose a newer design over an older one; most new designs are faster, and thus more fun to sail, so you'll learn boat handling quicker.

This applies equally to a new or used boat. On a used boat examine sails, centerboard, and rigging closely; they usually take a worse beating than the hull.

If you want to look over the field before choosing a class boat, the February, 1970, issue of *One-Design &*



Lightning is one of the most popular day sailers in the U.S. It's been around for 30 years and is made in wood, and fiberglass. Kits and plans are available, too.

Flying Dutchman races in the Olympic competition.

Thistle is a popular class boat—about 2,500 are registered in the U.S.

Fiberglass Comet is most popular in the eastern part of the U.S.

Lido-14 class started in 1958, now runs in 60 fleets.

Racing, Too

Offshore Yachtsman (159 E. Chicago Ave., Chicago 60611) contains an illustrated directory of the most popular ones. It gives specs, price, areas where the boat is most numerous, and the class secretary's address. A dollar will get you a copy.

Your local yacht club or sailboat dealer, alternatively, can get you the address of the class secretary for any boat. Besides specs on their boats, class secretaries have the addresses of people in your area who race the boats and have listings of used boats for sale.

Start small. It's best to match your first boat to your experience. A small centerboarder—a dinghy—is fine for a beginner. It's simple, easy to handle, and rightable if capsized.

The most basic dinghy has only a mainsail; if you know something about sailing, you'll want one with a jib, too. Later, for sheer fun rather than speed, add a spinnaker. It will develop your skill faster—things happen more quickly on a small boat.

You can learn to sail on an Aqua Cat—a catamaran—too, but you'll miss the heeling motion. A cat sails level up to the point when it loses stability rather suddenly, and flips.

As representatives of hundreds of boats in this beginner's group, I'd name the Aqua Cat, 420, IC Dinghy, Comet, Sunfish, and Rhodes Bantam.

For the intermediate sailor, a typical group might include the Day Sailer, Rhodes 19, and Mobjack.

More experienced sailors will enjoy the Highlander, Lightning, M-20 scow, and the Flying Dutchman. The Flying Dutchman is an Olympic boat, a very sophisticated racer. The Windmill fits into both the intermediate and advanced groups; it can be sailed routinely or like a tender little machine in the hands of an expert.

How fast do they go? Speed in a race is relative, since everyone has an almost-identical boat. Even a two-mile-an-hour breath of air can be exciting when you're trying to get more out of it than the other fellow. The average breeze that most small-boat sailors find comfortable, however, is about eight miles an hour. It moves you along nicely, but won't capsize the boat if you do something foolish.

If you have the skill and nerve, you can get some of the planing centerboarders up to 15 and 18 mph. Catamarans and scows will hit 20 to 30 mph in heavy winds. A boat's speed, incidentally, tends to be directly proportional to its size, although there are exceptions to this general rule. A big centerboarder will go faster than a small one; a big cat will go faster than a small cat.

I'm not knocking speed on the water. It's exciting and teaches you more about sailing. But, as any experienced sailor will point out, you don't have to sail fast to have fun.

If sheer speed were so important, sailboats would have faded out long ago as runabouts and cruisers multiplied. The fact that sailboats, too, are gaining in popularity every day suggests that there's more than one way to enjoy the water. Why not try them both?

Interclub, an 11½-foot dinghy, is a popular fiberglass or wood sailboat used in frost-bite competition. Standard model is $775, racing model about $150 more, with sails.

Snipe, world's most popular conventional class sailboat, available in wood or fiberglass.

The 420 has a fiberglass hull designed for planing—a boat that can make speed.

Rhodes Bantam is a 14-footer available in hulls made of wood or fiberglass.

Aquat Cat is the world's most popular catamaran. You can cartop it on a VW.

Alcort Sunfish is an economical way to get into sailing. Kits cost about $320.

The Wankel-powered Mercedes-Benz C-111 looks wild and has staggering performance. It's designed to be a trend-setter for the seventies

Uhlenhaut briefed Norbye on shift points and maximum revs, then let him go it alone.

Driving the C-111 with Dunlop racing tires

Come Drive Mercedes'

As you drive at Hockenheim race circuit in Germany one morning, you are confronted by three of the most exciting-looking cars ever built—and by a group of the engineers who built them. Chief of passenger-car development for Mercedes-Benz, Rudi Uhlenhaut, puts you in the driver's seat and starts to tell you about the controls. Sooner than you expect, he tells you to start up and get moving.

You turn the key. You hear something firing up behind you, and know right away it's not that long-rumored V-8. It's a triple-rotor Wankel engine! What does it sound like? If you can imagine a high-pitched 300-hp. lawn-mower, I'd say that's about it.

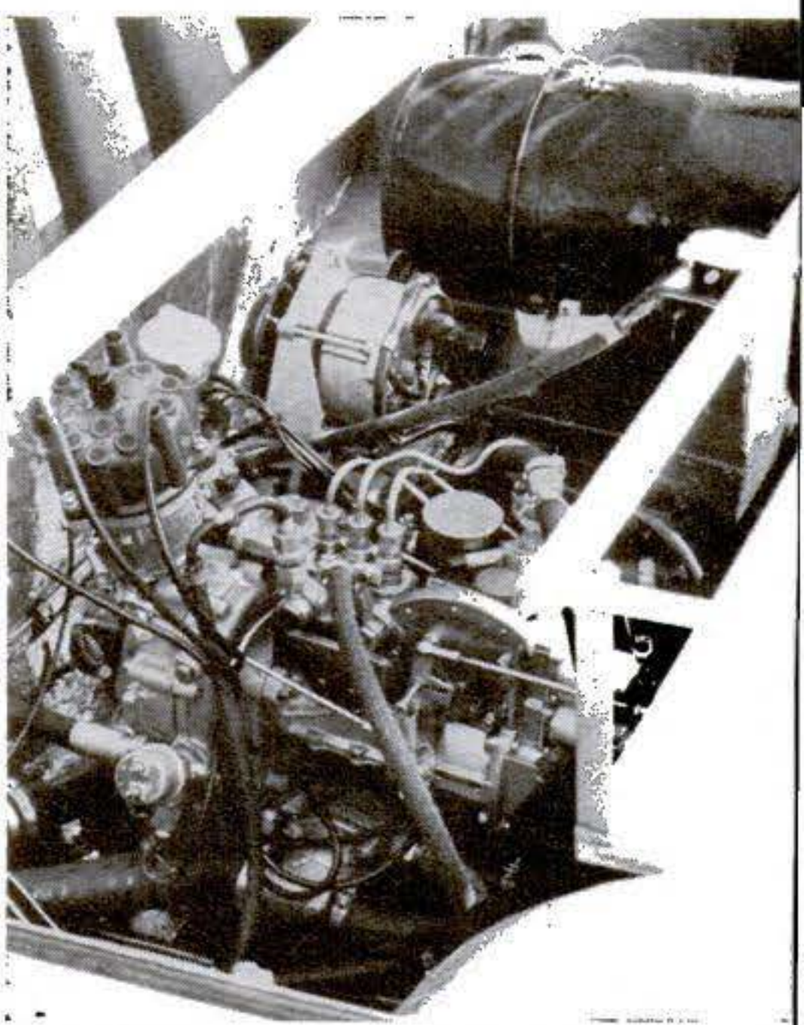
You push a lockout button on the five-speed shift lever and engage first, prudently. You give gas, and ease out the clutch.

Sudden silence. The engine stalled. Fire it up again, get it turning about 2,500 rpm, then ease out the clutch, and you're off.

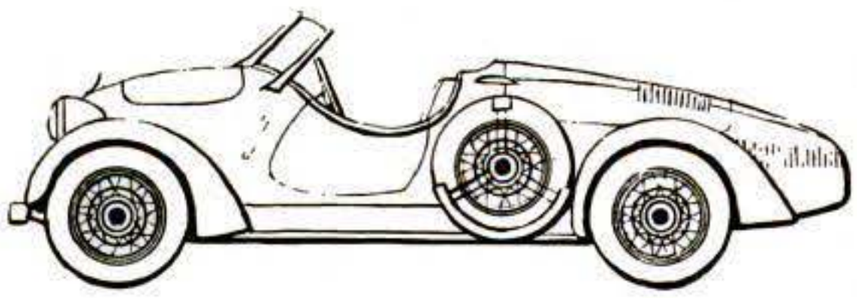
You floor the loud pedal, and it seems a second later you've reached 7,000 rpm and it's time to get into second. A glance at the dial tells you your speed is 52 mph. Keep pushing. The shifts are slick and smooth—soon you're in fourth and approaching 125 mph! Wham! You snatched fifth with hardly a stab at the clutch and now you're really rolling. 130 . . . 135 . . . 140 . . . 145.

Here it's getting a little skittish. The roadway isn't quite smooth, and

[Continued on page 148]



The 300-hp. Wankel is little larger than a vacuum cleaner and nests in center of chassis, below the luggage compartment. Check drawing for parts identification.



Mercedes' first midships-engined car is not the C-111 but the obscure 150-H from 1934, with its four-cylinder engine placed behind the seats but ahead of the rear wheels.

Cockpit is well laid out, with controls exactly where they should be. Instruments are deeply recessed to avoid glare; tach and speedo are right in line of sight.

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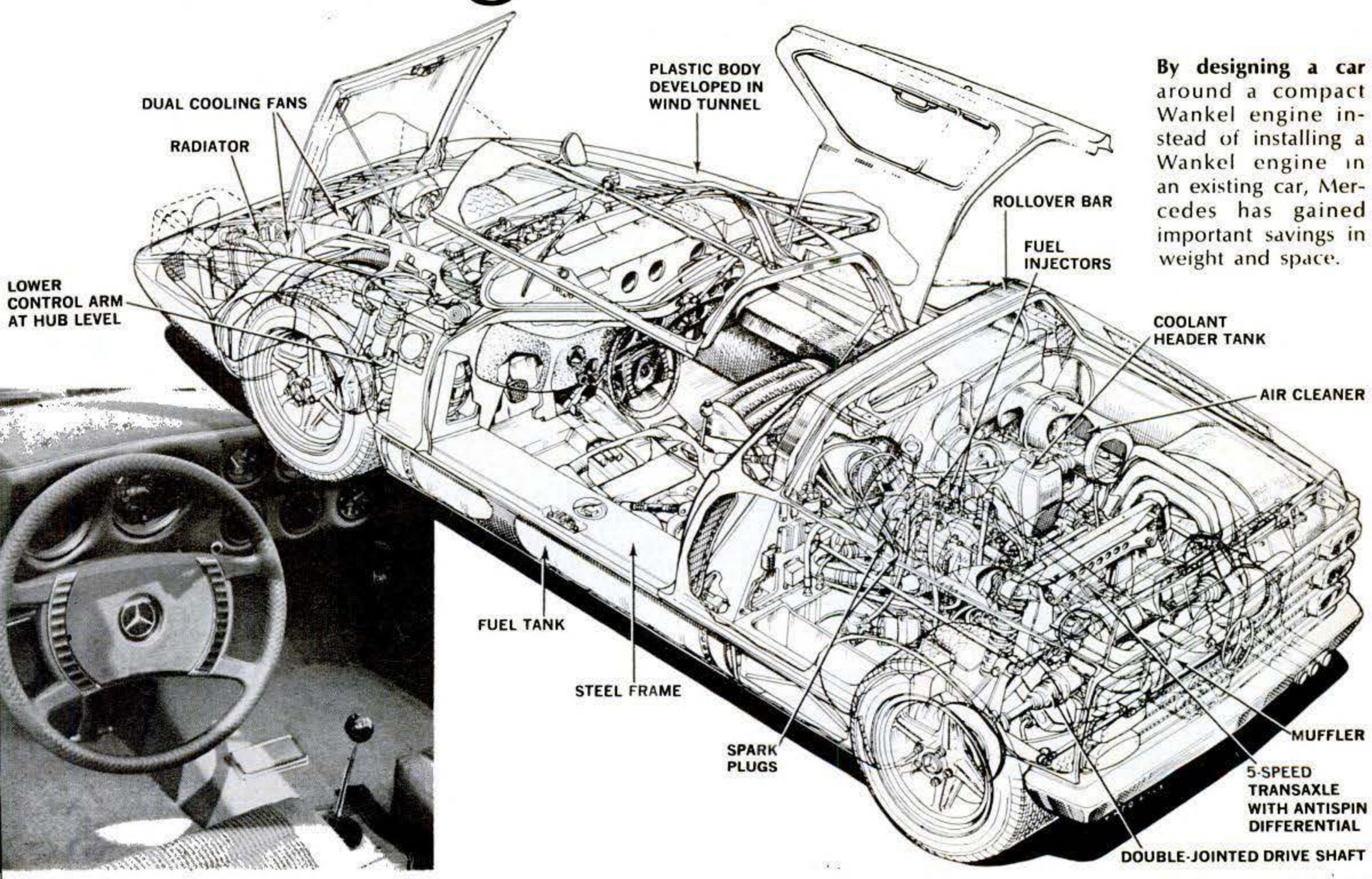
orbye found that the car did not "drift" through curves but simply went where it was pointed—and it did that with alarming alacrity!

Wunderwagen–WOW!

By JAN P. NORBYE
PS Automotive Editor



By designing a car around a compact Wankel engine instead of installing a Wankel engine in an existing car, Mercedes has gained important savings in weight and space.

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World's Biggest Furnace Runs

With mountain of mirrors, French scientists trap solar heat of 7,000 degrees

By DAVID SCOTT
PHOTOS. CENTRE NATIONAL de la RECHERCHE SCIENTIFIQUE

High in the Pyrenees Mountains of southern France, the world's largest solar furnace raises metals and rare earths to the incredible temperature of 7,000 degrees F to investigate their properties, grow giant crystals, and even make gems like rubies and sapphires.

As a schoolboy scorches a hole in paper with a burning glass, this installation focuses sunshine on a crucible, yielding enough heat to burn a hole in a two-inch-thick steel plate—burning through almost instantaneously.

It is located at Odeillo, the sunniest spot in France, with 175 cloudless days a year. Sited on a mile-high southern slope, the gigantic heat trap reflects sunlight from an array of 63 flat mirrors onto a mammoth paraboloid, which in turn concentrates the beam upon material to be heated. It's the opposite of what happens in your car's headlights, where light scattered from the tiny filament is directed in parallel beams by the reflector behind it.

The paraboloid mirror stands high. It forms the entire north face of an out-of-this-world 10-story building that houses scientific laboratories and administrative offices. Covering two-thirds of an acre, this mammoth reflector has a mean diameter of 160 feet.

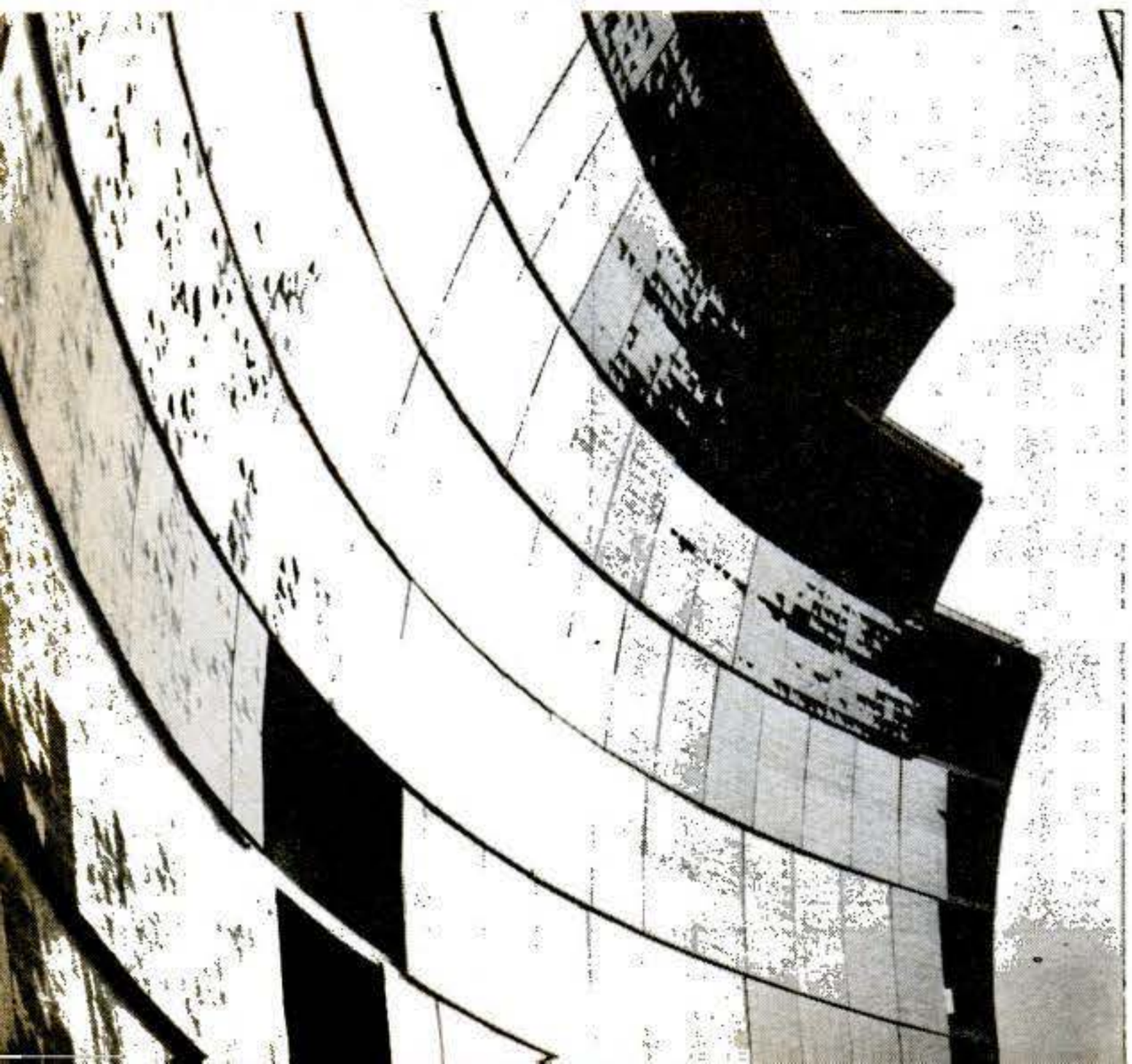
It is made up of 9,000 small panes, each 1¾ feet square. These are arranged in panels of 50, with every piece of glass held individually by four adjustment screws at the corners. Fastened on a saucer-like frame, the panel assemblies are accurately contoured to parabolic shape, varying from nearly flat at the edges to decidedly concave near the center.

Where things happen. In front of this reflector, a curious T-shaped building stands some 90 feet high. Inside it, exactly 59 feet from the center of the paraboloid—its focal length—is the heart of the solar furnace. This is the focal point of the paraboloid, a circle 18 inches in diameter, with the heat energy concentrated in an inner 10-inch bull's-eye. In this hearth zone is the crucible, served by a 10-ton "dumbwaiter" that hoists up materials from ground level.

The crucible can take up to three tons of metal at a time. It is designed to rotate slowly, to apply the intense heat evenly. Fundamental physical research can be done in a chemically pure environment, since there are no gases or other combustion products to contaminate the atmosphere. In fact, the material can be suspended in the hot box so that even contact with the crucible is eliminated.

To keep the solar image trained upon the crucible, the

Close-up of 10-story-high parabolic mirror shows curved shape —and arrangement of 9,000 mirror panes, assembled in panels of 50, each piece fastened to saucer-like frame by four adjustable screws. Mirror brings sun's rays to focus just 59 feet away.



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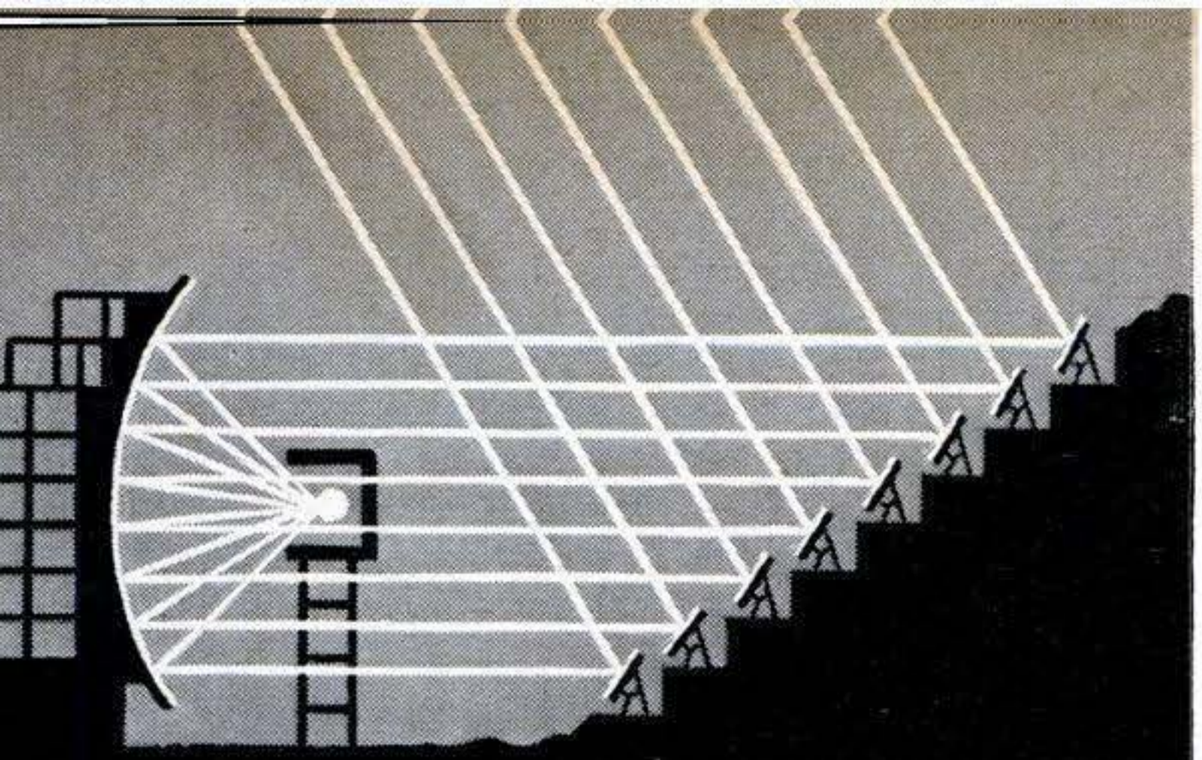
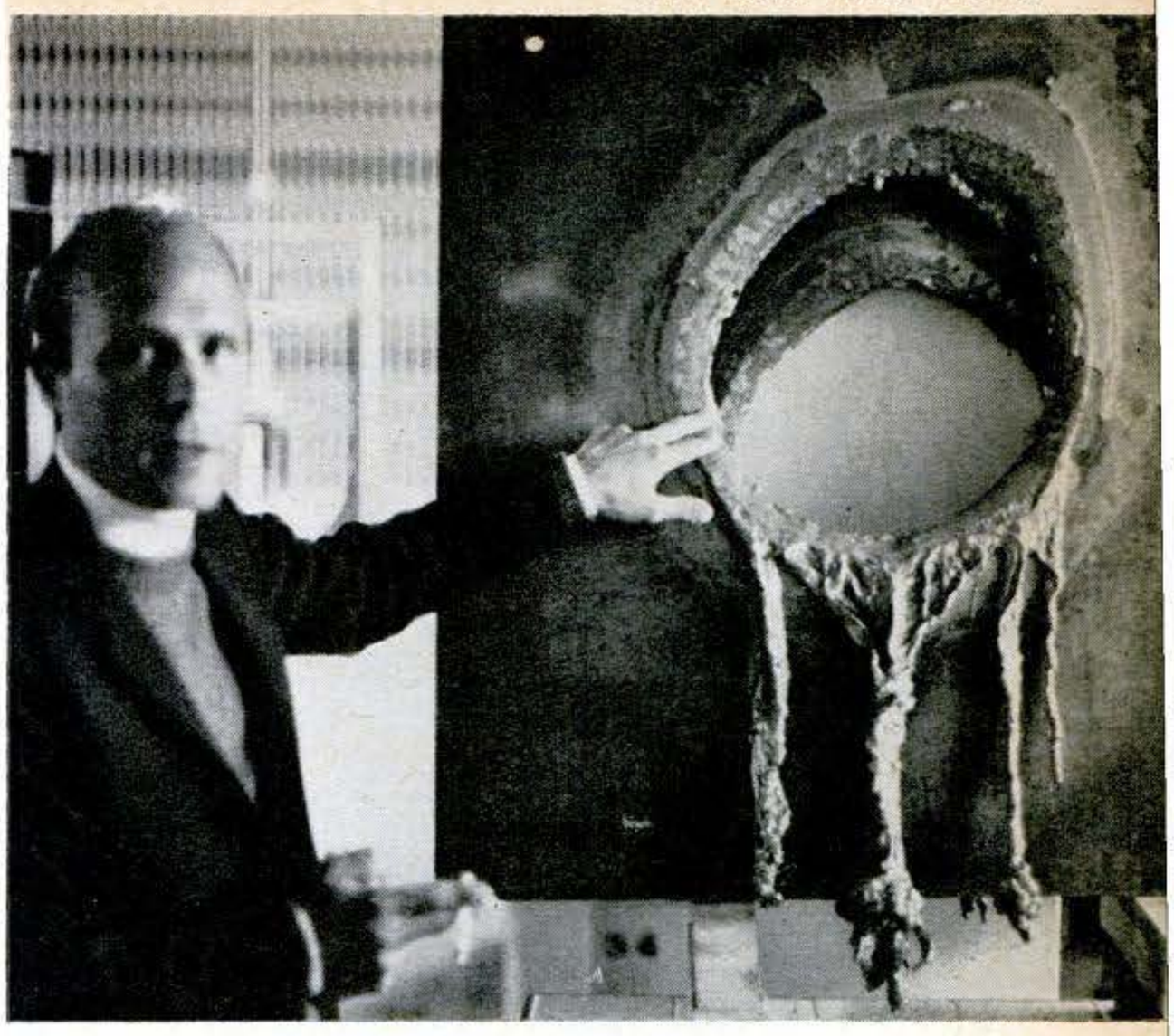


High in French Pyrenees, solar furnace (left) mounts a dazzling display of mirrors. Nine thousand of them line the parabolic north wall of nine-story lab and office building. Aimed at the wall is a tiered array of 63 movable panels—glittering with 180 mirrors apiece—that track the sun across the sky. Drawing (above) shows how movable mirrors bounce the sun's rays to the giant reflector, which concentrates solar energy on a crucible inside hammerhead structure at the paraboloid's focus. Massive steel shutters shield the crucible when furnace is not operating.

NEW YORK TIMES PHOTO



Here is what happened when 7,000-degree heat of solar furnace was focused on half-inch-thick steel plate. Great hole burned in it is pointed out by Jean-Francois Robert, one of project engineers.

on Sunshine

for tests that melt up to three tons of metal

mirror system must somehow follow the movement of the sun across the sky. Because of the unwieldy size of the giant paraboloid, it remains stationary and the flat mirrors do the sun-following.

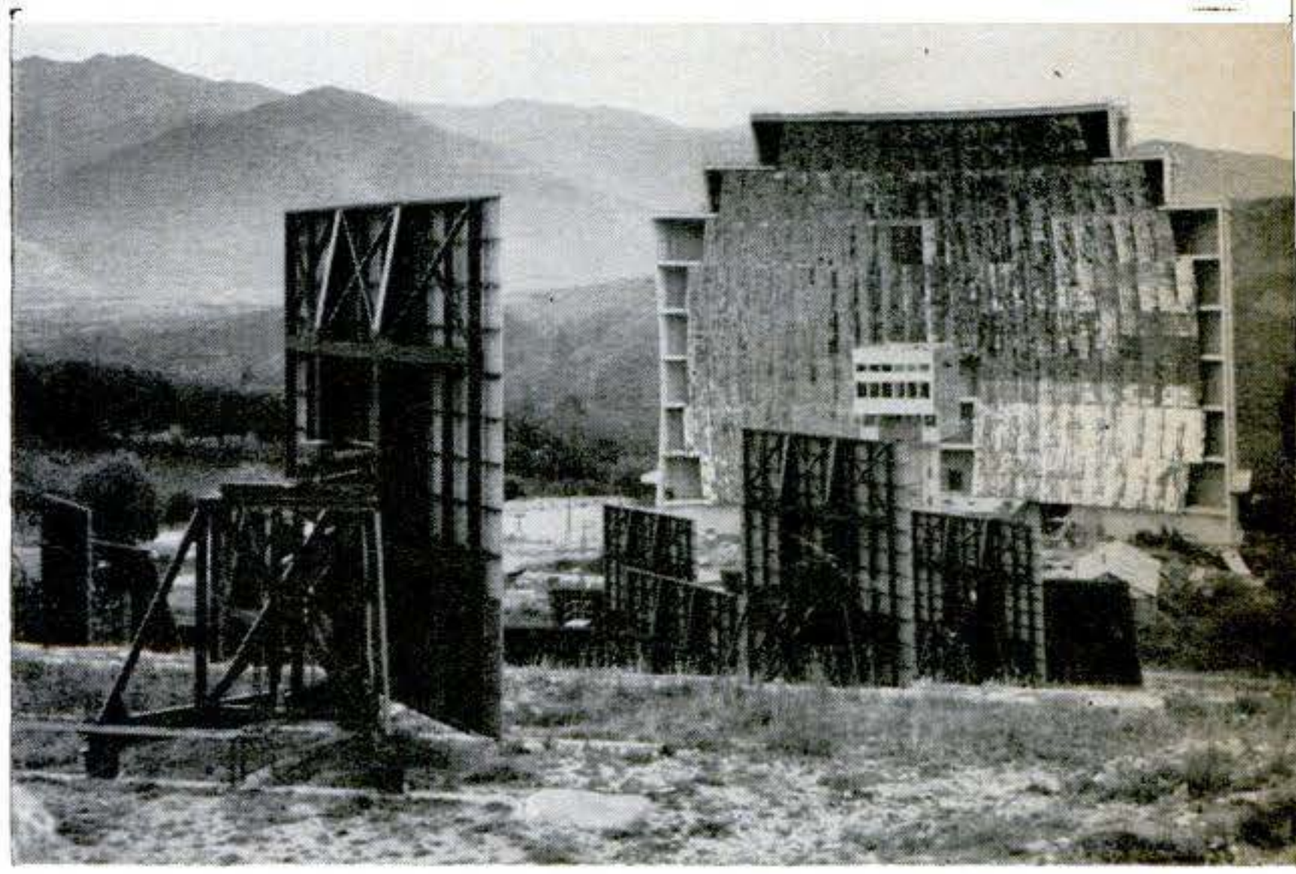
How mirrors follow sun. The 63 flat mirrors, each with an area of 585 square feet, are arranged in eight rows on the terraced hillside so that none casts a shadow on another. Individually aimed at different points of the paraboloid, they give the parallel beams of the headlight analogy. Each flat mirror is free-standing on its own base, and automatically pivots and tilts through the day to trail the sun. Optical tracking keeps them on target.

In front of each mirror, a fixed telescope is permanently zeroed-in on a selected point on the paraboloid. An adjacent and parallel tube contains a ring of photocells behind focusing lenses. Sunlight reflected from the mirror is centered in the ring. But, as the earth rotates, the pencil beam moves off-center and illuminates one of the cells.

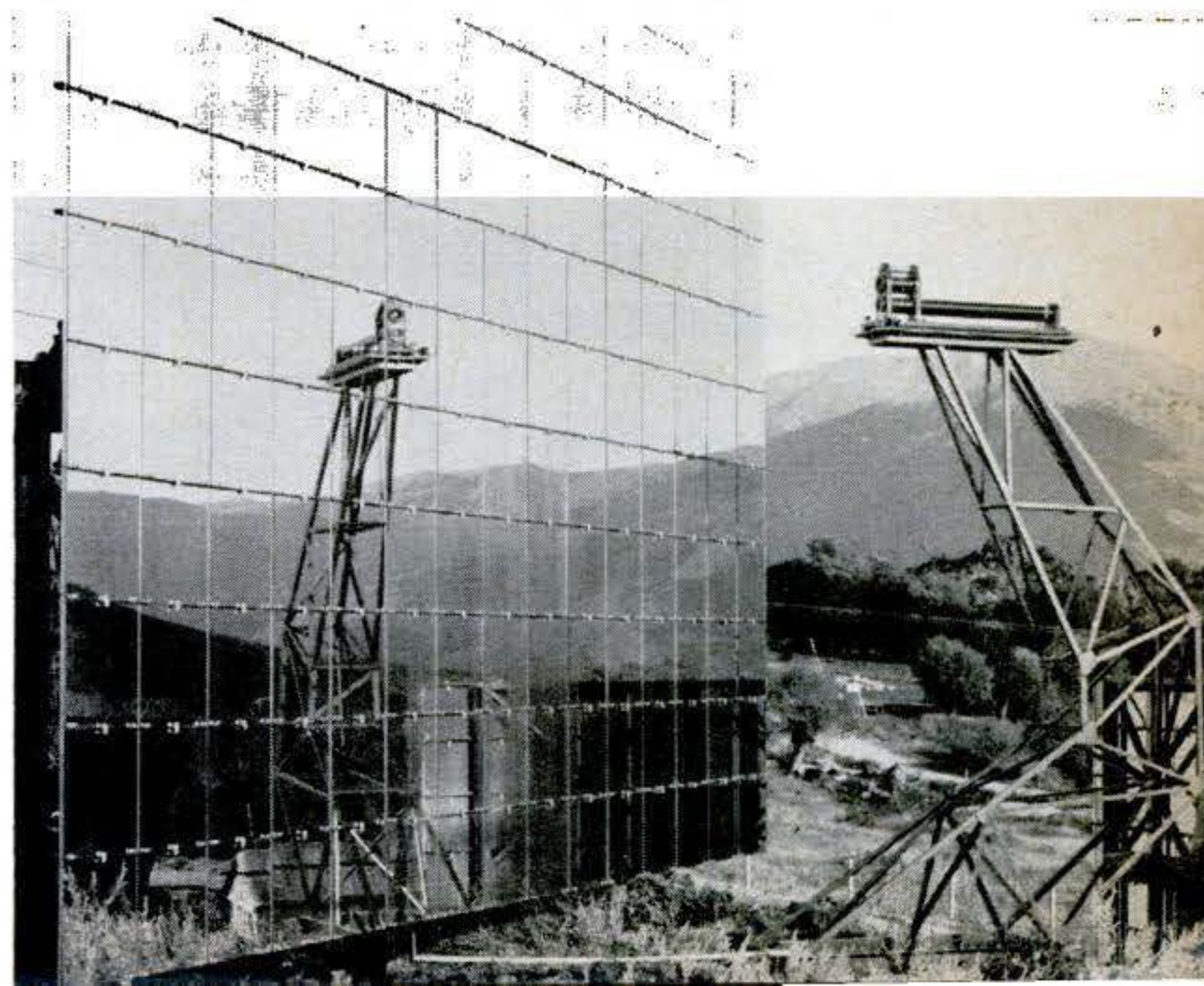
Current from the activated cell goes to a mini-computer controlling a pair of hydraulic cylinders. They reposition the mirror in two planes, for both azimuth and elevation. As the mirror inches back to correct aim, the reflected sunbeam returns to the center of the light-sensitive ring. The moment this happens, the blacked-out cell cuts off the servo muscles and the mirror stops dead to await the next nudge in the direction of the moving sun. After sunset, the mirrors are reset by hand to the sunrise position, so that tracking can start automatically the following dawn.

Workers at Odeillo have already made crystals without internal stresses, for electronic and nuclear applications; refractory materials for metallurgy; pure metals and alloys; and high-temperature analyses of exotic substances like zircon and thorium.

Built and operated by the French government's National Center for Scientific Research, the solar furnace took 10 years to build and cost $4 million. It has become an invaluable research tool for a number of industrial corporations as well as public agencies.



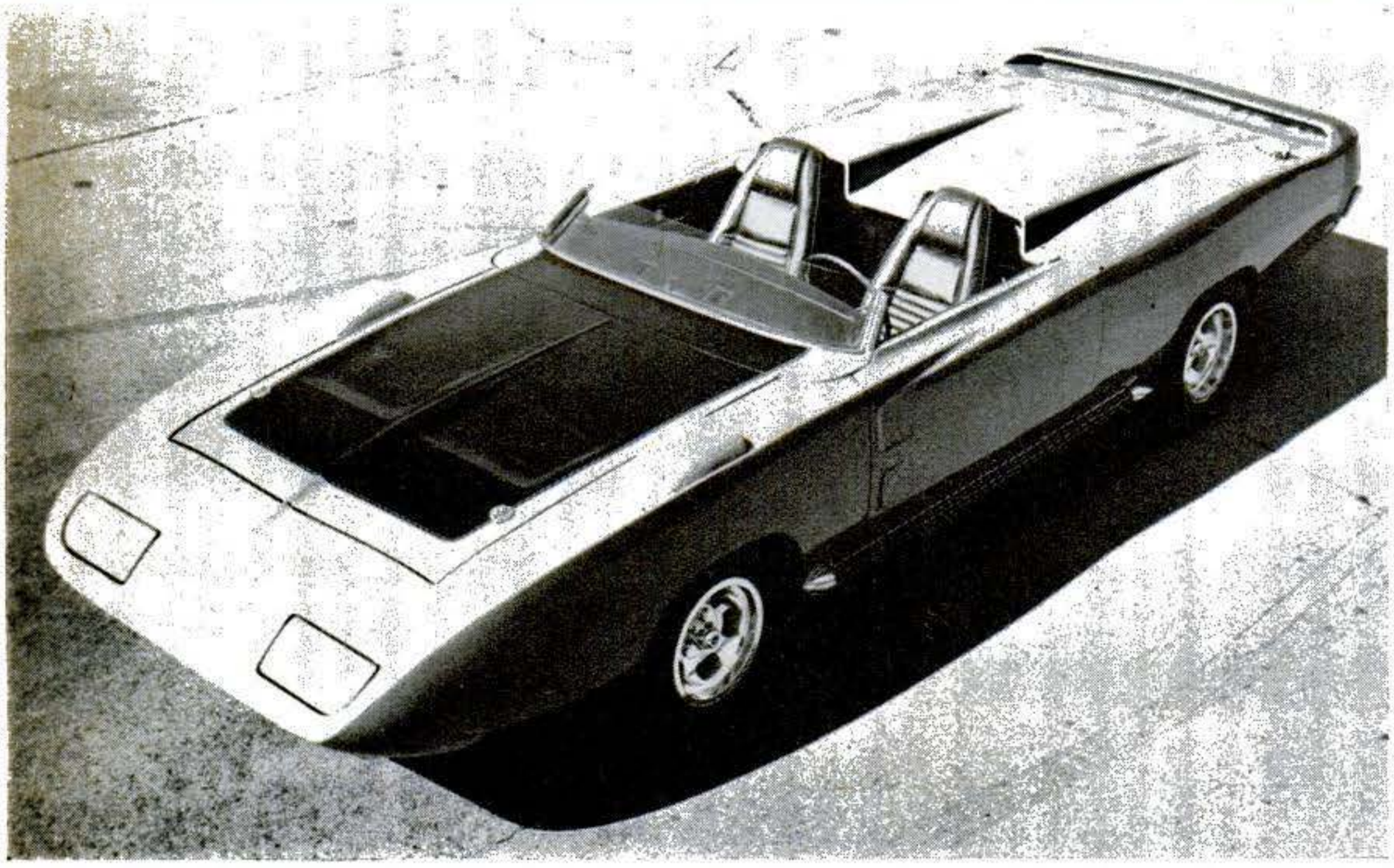
Flat mirror (left foreground, above) is one of 63 that reflect sunlight to giant paraboloid towering in background. Each flat mirror automatically turns and tilts to follow sun across sky, in response to optical control system (below). Seen on stand at right, and reflected in polished mirror, are sighting telescope trained upon selected point of paraboloid and, above it, parallel tube with ring of photocells, which actuate hydraulic cylinders that correct aim of flat mirror to keep up with travel of sun.



What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

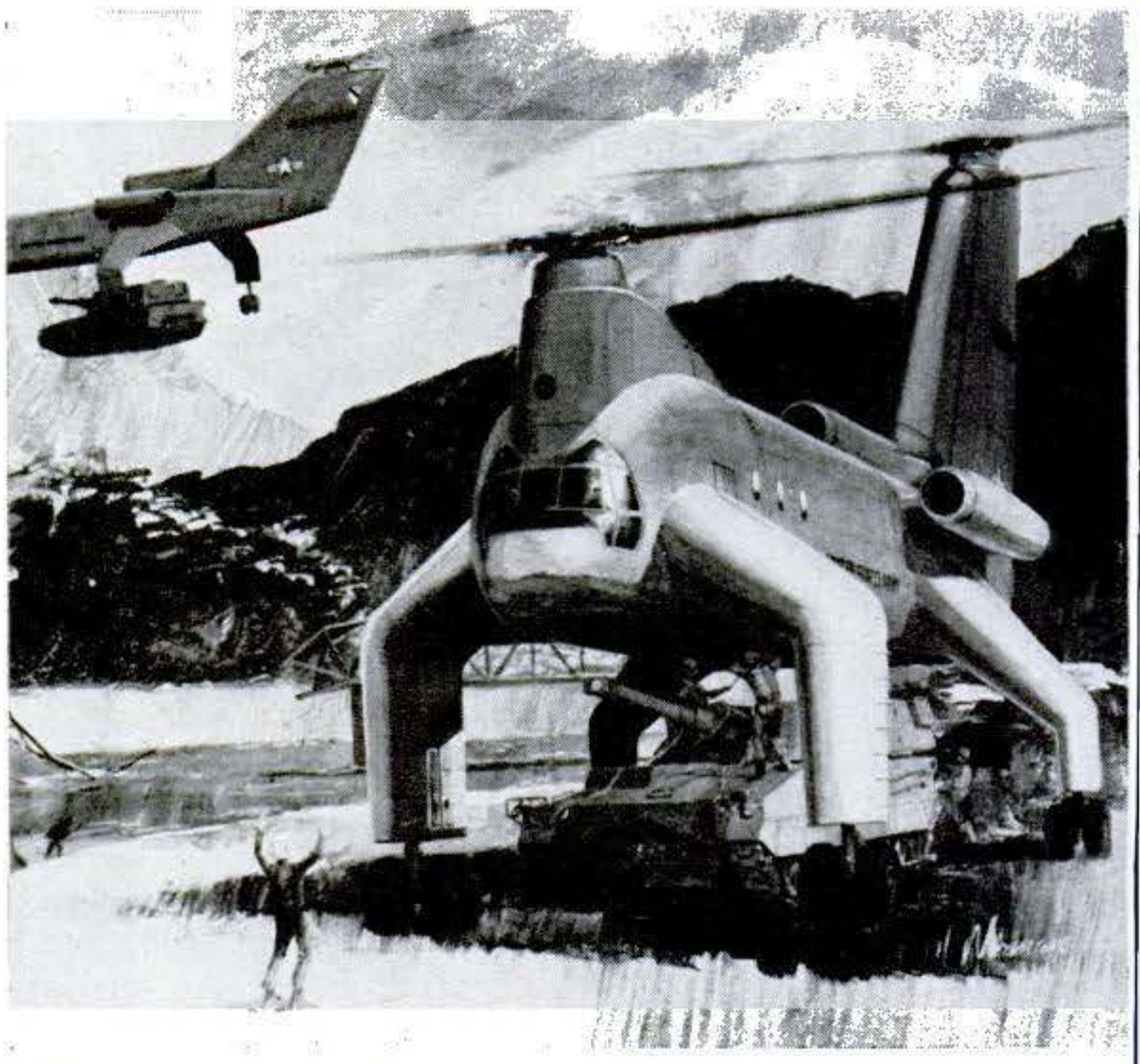
Flash furniture ▲
Four interconnected cushions—a triangle and three semicircles—let you make free-form furniture in a flash. Above is a chair. Flop the top seat cushion to the right and you have a lounge chair. Turn back the triangle for a low couch. For storage, the German unit rolls up in an easily stored cylinder.



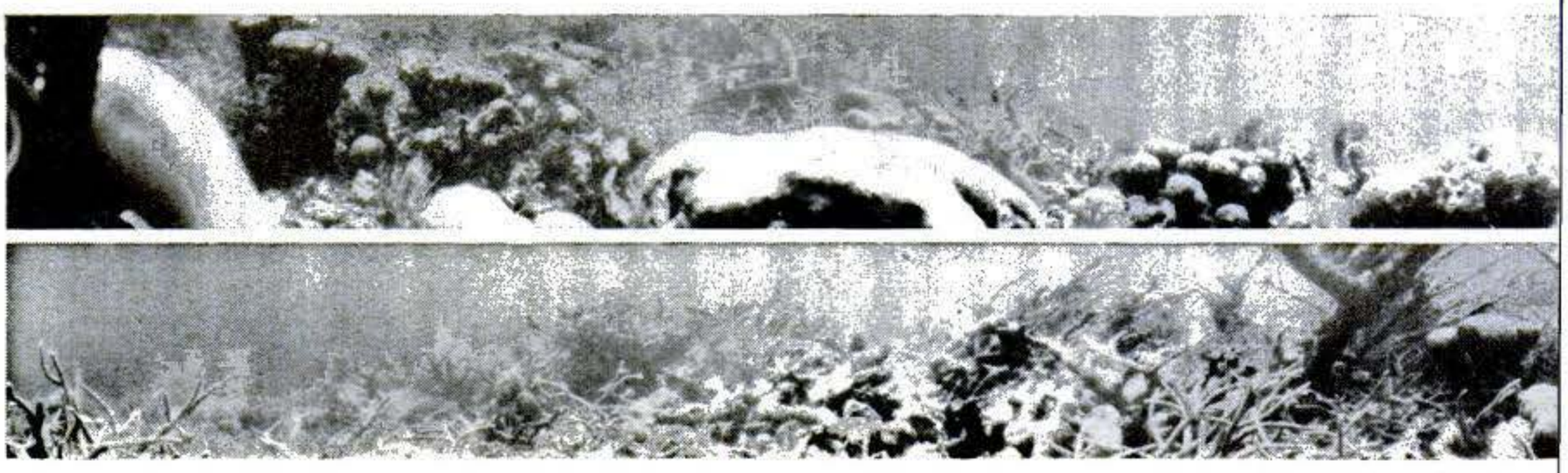
◄ Topless go-go car
Take a 440-cu.-in. Dodge Charger, chop off the top, cut the windshield to 10½ inches, louver the hood, add an electrically operated spoiler and a sleek shark nose—you've got a Super Charger. Dodge stylists dreamed up the flashy two-seater for display at custom auto shows throughout the country.

▼ Blow-up boat
Rugged is the word for this inflatable German boat—the Zephyr. It has four independent air chambers, and a patented inflatable keel, all of neoprene and Hypalon-coated fabric. The specially designed hull gives the 15-footer a top speed of 28 mph with a 40-hp. outboard. It seats eight.

Cargo bird ►
The "brain" of this flying monster is in one of its front "feet." From his station there, the loadmaster could control the copter during cargo pick-up and delivery. During normal flight the Heavy-Lift Helicopter (HLH), being developed for the Army by Boeing, would be piloted from the regular cockpit.



Navy wide-eye ►
The Navy's NavScan underwater camera can see behind its back, as the 350-degree pictures at right demonstrate. Secret: a rotating lens in its dome. Light rays, refracted downward by a prism, bounce off a mirror onto the film. Distortion-free pictures can be used for accurate measurements of ocean floor.



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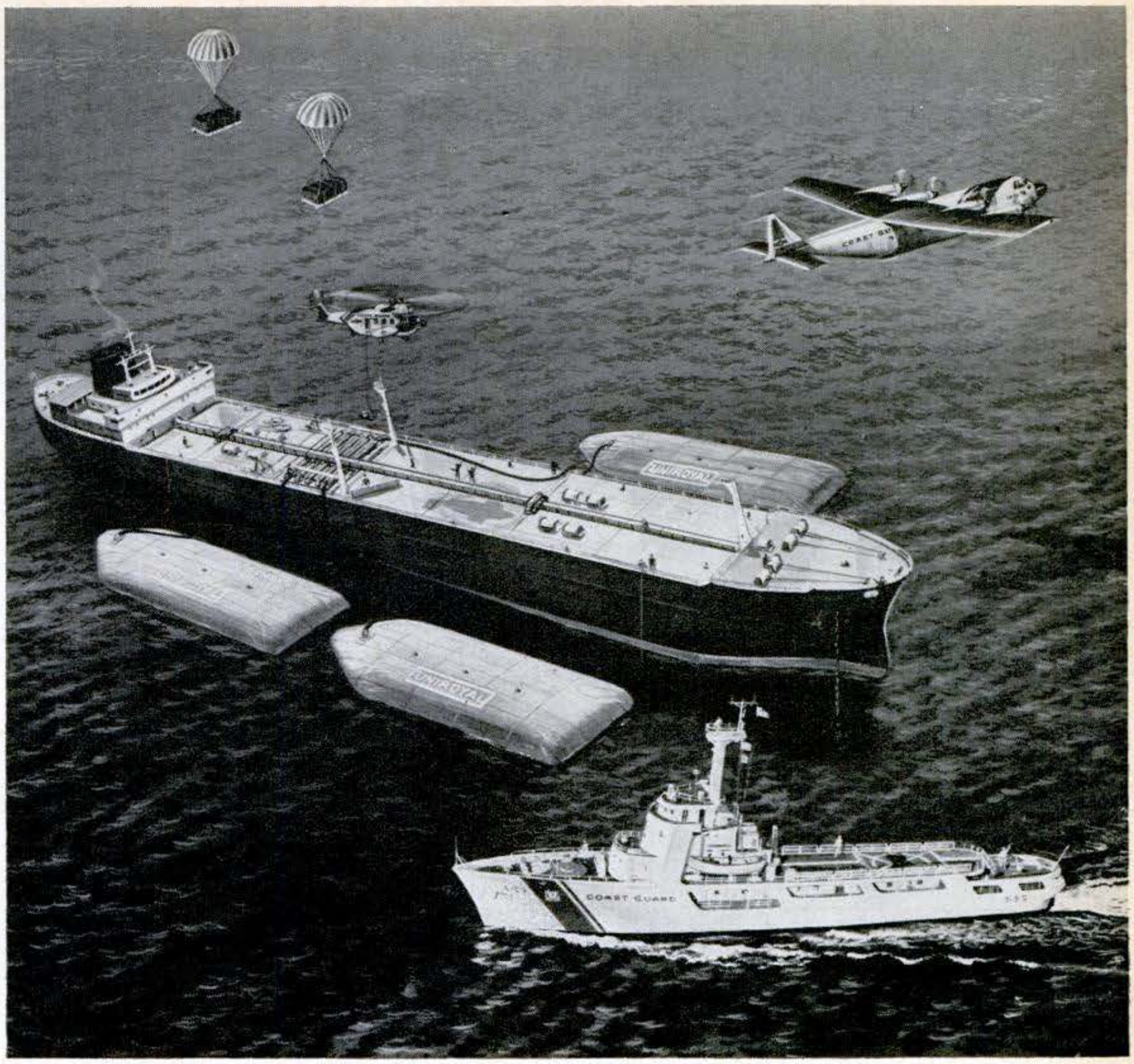
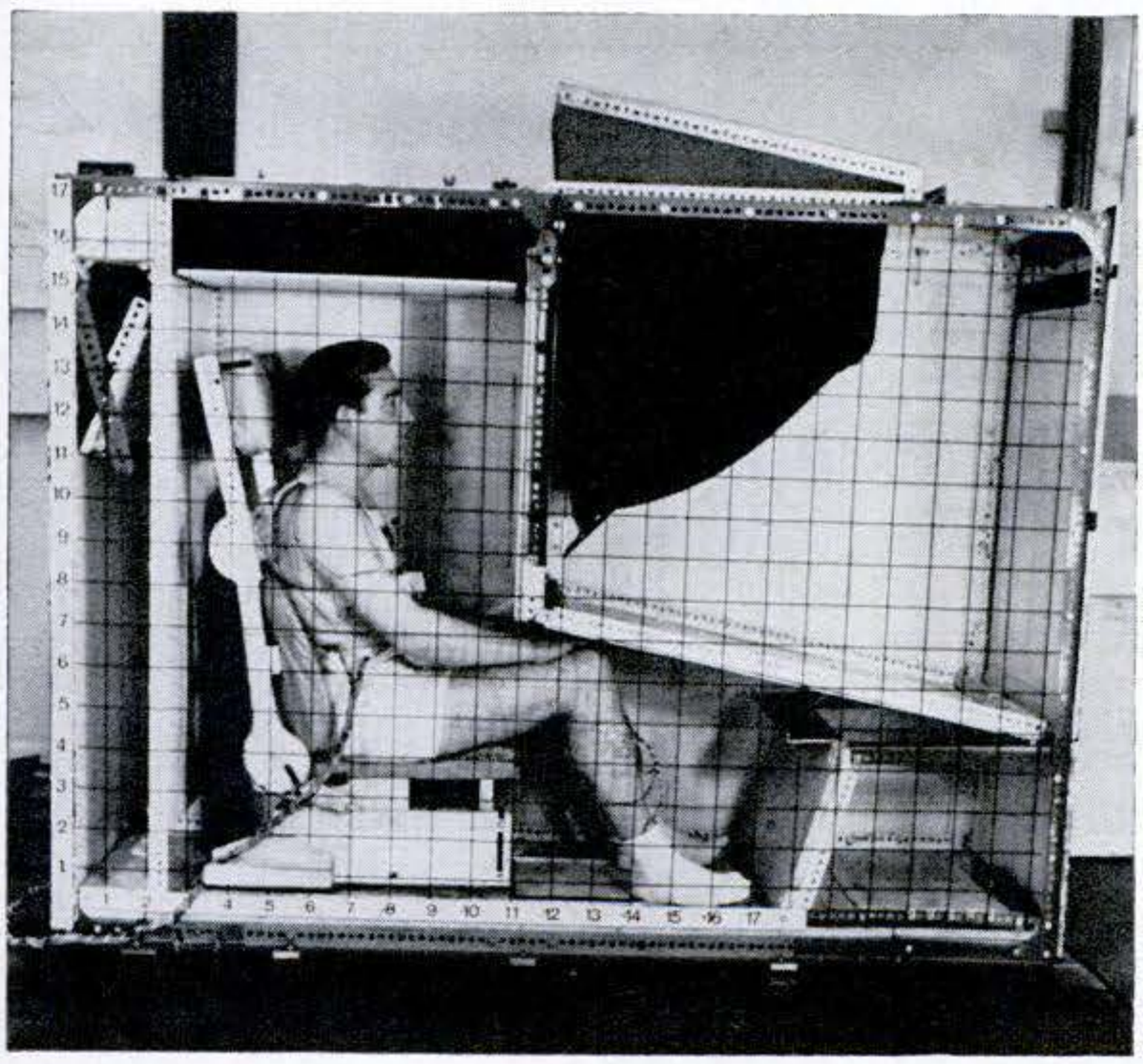
Slop-stopper
Airline passengers won't spill their coffee, tea, or milk, even in the roughest weather, with this plastic insert in their cups. Specially designed baffles deflect sudden surges of liquid, but don't interfere with normal drinking. Dinegard *R* is made by Production Plastics, Seattle.

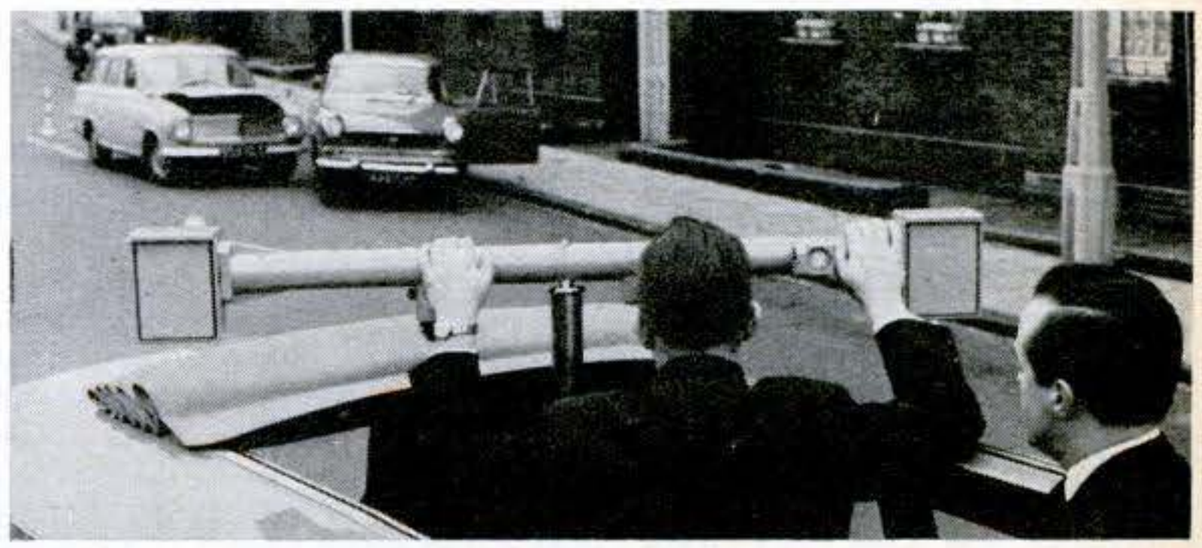
Anti-slick trick
Giant inflatable tanks are the key to a Coast Guard plan to fight pollution from leaking oil tankers. Planes would drop the self-inflating rubber tanks near a stricken ship, and choppers would fly in pumps and pipe. Oil could then be pumped into the 140,000-gallon tanks and towed to port by Coast Guard cutters.





Squeeze tester
Feel confined last time you flew coach? A look at the man in the cage at left might give you an idea of what's in store for you in the future. He's the subject of British tests being run to help airliner designers find out just how little space passengers can get by with in tomorrow's SSTs.

Mishap mapper
One shot tells all, in 3-D, with this new Zeiss accident camera—actually two cameras mounted at the ends of a pole. They produce a stereo picture through fixed-focus *f*/11 lenses on nine-by-12 cm sheet film. By placing markers a known distance apart, London police (below) use the pictures for accurate mapping.



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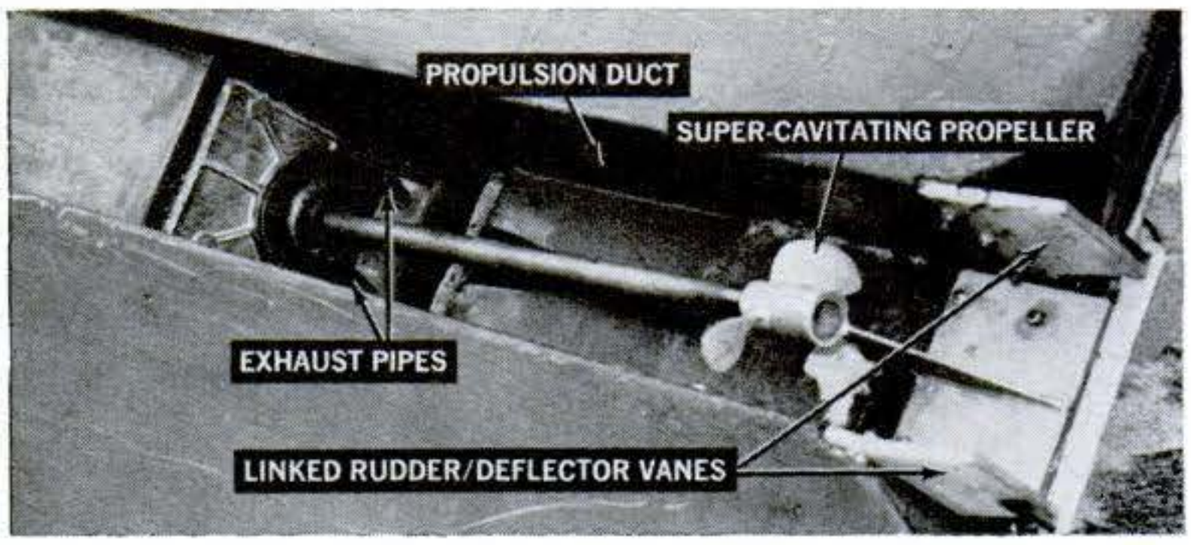
What's New

▲ Electric scorer

Stay on the firing line—no need to check your target with Marksman's electric shooting range. Colored lights flash to indicate instantly the scoring ring you hit. Four C cells provide the power. Safe for indoor or outdoor use with air rifles and pistols (a trap catches BBs and pellets). Price: $19.95 with targets.

Waterborne Wankel ▲

Run her aground? Sure, matey—you can't hurt this tiny, 10-hp., Wankel-powered British scootabout. The propeller is nestled safely in a rectangular duct (right) in the base of the plastic hull. Deflector vanes at the rear do the steering. Top speed is 25 mph with crew of two. The QX-2 will sell for $800.

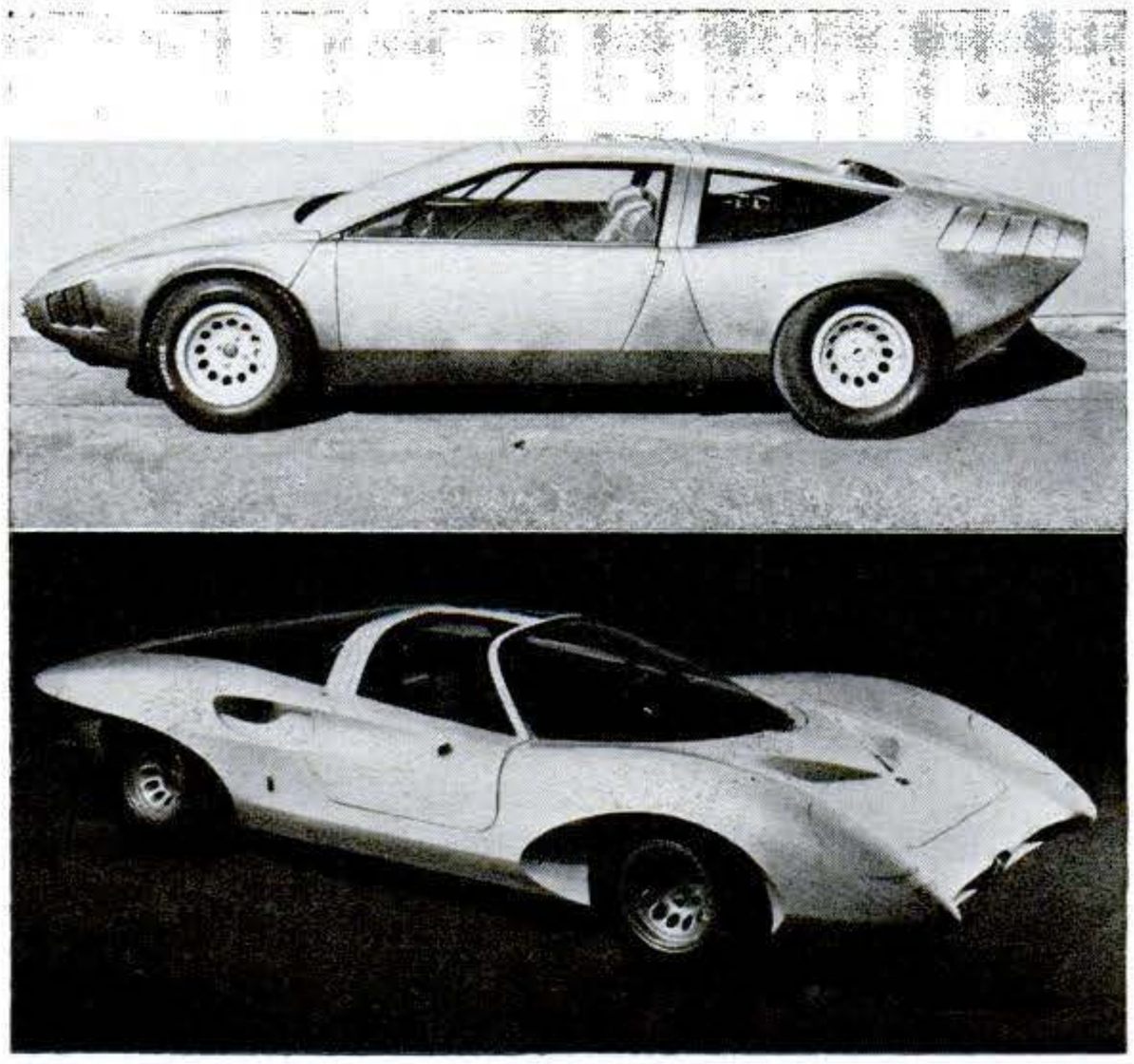


◄ Easy rider

Forget ball couplings! This new English trailer hitch connects to the rear wheels of your car. Result: Trailer togue weight is passed directly to the ground, by passing rear suspension and chassis. And there's no effect on car level. The hitch clips on a star-shaped plate slotted to fit all wheels.

Two aerodynamic sports coupes from Italy ►

What kind of body would you wrap around the midships-engined Alfa-Romeo Type 33 chassis (with 120-cu.-in., 235-hp. V-8, six-speed transaxle)? These prototypes show what two competing coach builders can do. The top one is by Ital Design (Giorgetto Guigiaro, who did the Fiat 850 Spider); the other is by Pininfarina, who designs all the GT bodies for Ferrari. Both are designed for extremely low drag and low aerodynamic lift at high speeds. The integral "spoiler" below the rear window on the Ital Design car keeps the rear wheels on the ground even at top speed—about 200 mph. Both bodies have built-in roll-over bars to protect the driver.



Talking pictures ▲

This owl-faced machine talks to your kids as it shows them 3-D pictures. A built-in sound playback system in the GAF Talking Viewmaster automatically narrates picture tours through U.S. parks, the Apollo Space Program, Walt Disney's Jungle Book, etc. Price: $14.95. Packetts of three talking-picture reels, $2.95.

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What's New
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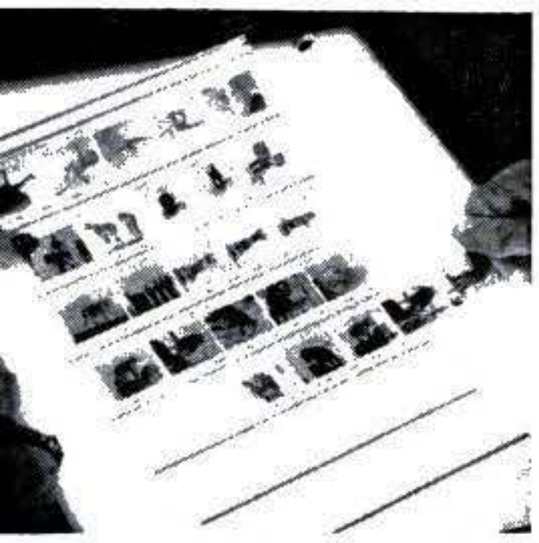
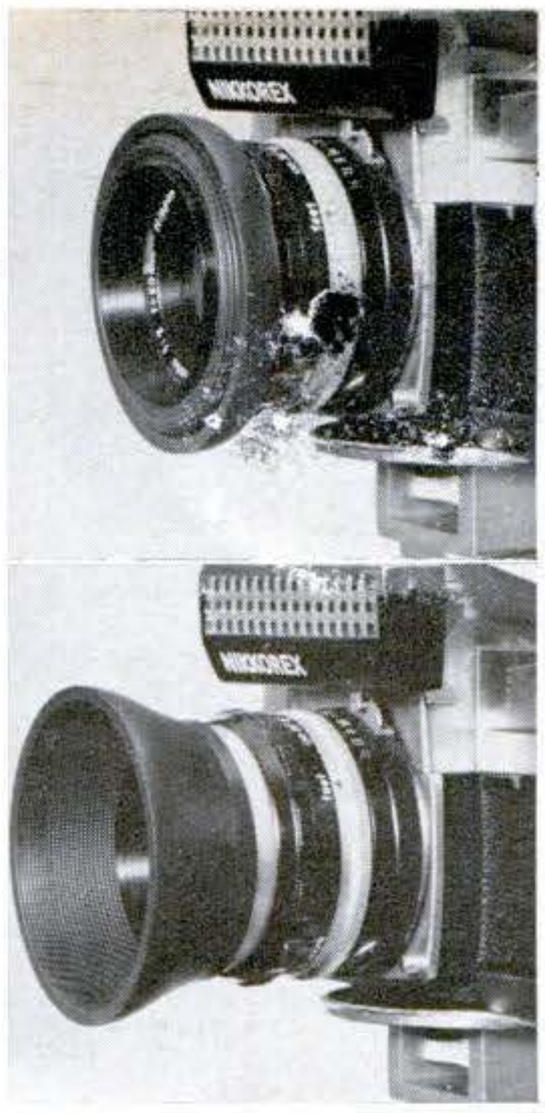


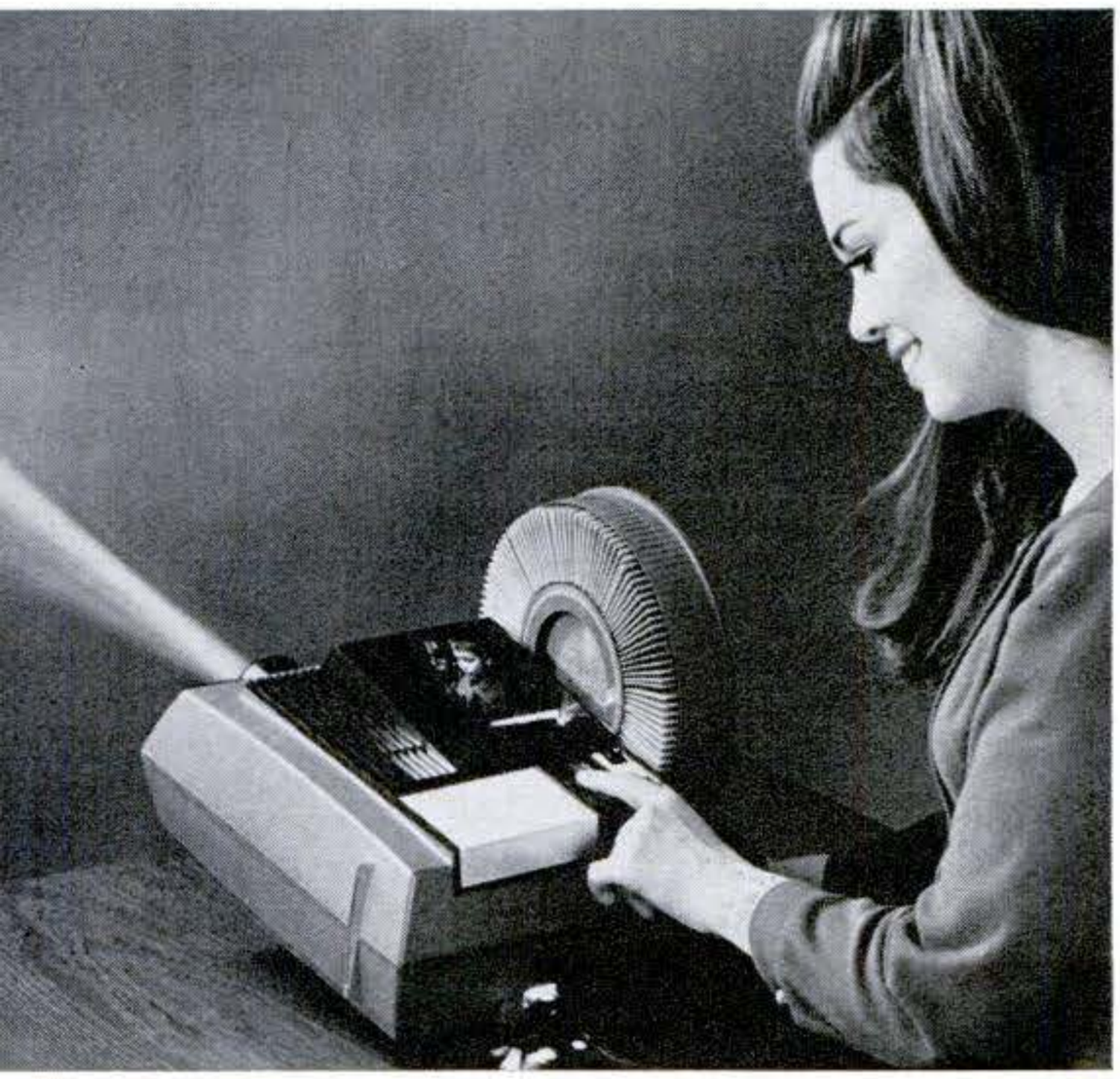
Negative idea

ooking for a way to store and atalog negatives and proofs? lip your negatives into ne channels in this clear cetate sheet, make a contact roof, and file the sheet with ne proof. The sheets are nade in sizes for 35mm and 20 film. Six cost $2.95 from ue-All, 49 W. 45th St., lew York, N.Y. 10036.



Folding flarefighter ▲

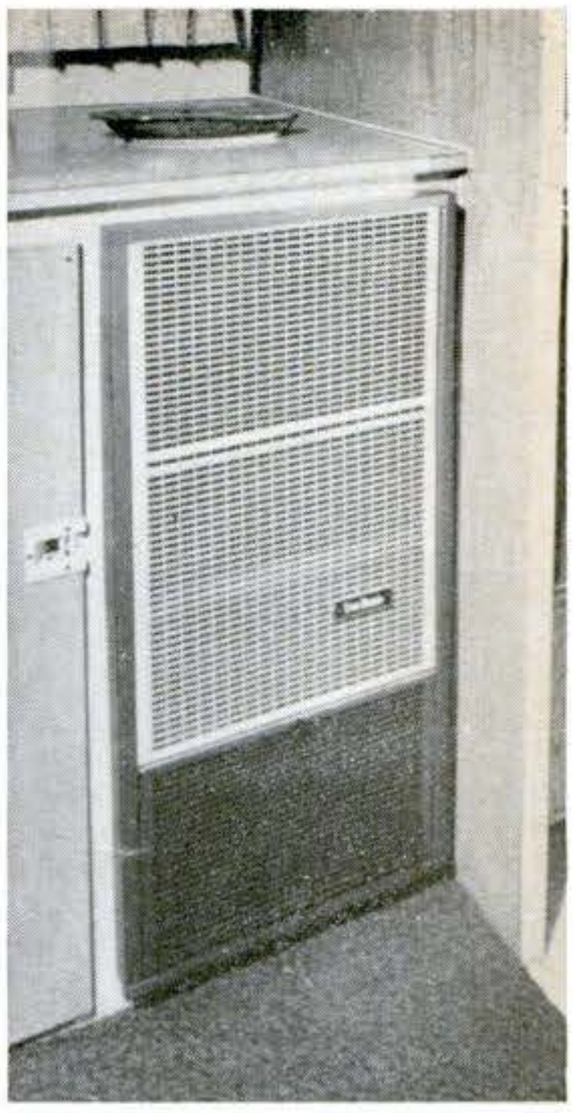
You can leave this lens shade in place even when your camera is in its case. It's made of flexible black rubber so you can fold it back over the lens barrel when you store your camera, snap it out to cut flare when you're shooting. Made by Kalimar in 48-58mm screw-in sizes to fit most 35mm cameras. $3.00.



Heads-up series of slide projectors

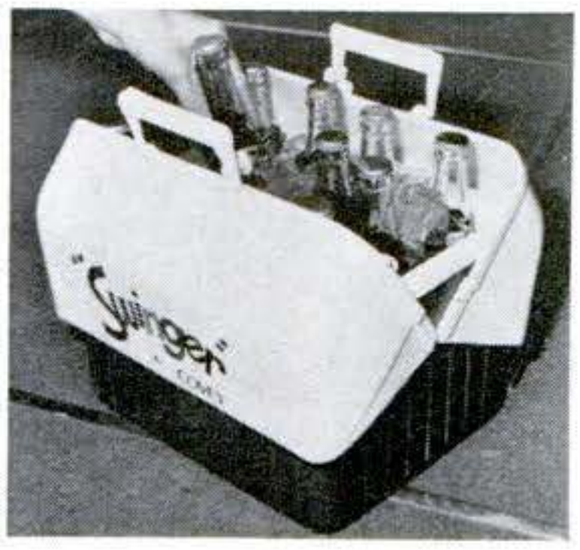
ou'll never show an upside-down slide with any of Honeyell's 16 new Preview projectors. While one slide is being hown you can see the next one on a preview screen atop he projector. If it's upside down or backwards, you can reosition it while the other slide is still on the screen. Other eatures on the new projectors include: Instant auto-focus, emote control, automatic timers, zoom lenses, and automatic ind-up reels for the power cord. You can get a variety of ide-handling systems, too: a 120-slide rotary tray, Sawyer's 00-slide rotary, various straight trays, and—in the future—stack loader. Prices range from $109.95 to $199.95.

What's New
IN OUTDOOR RECREATION



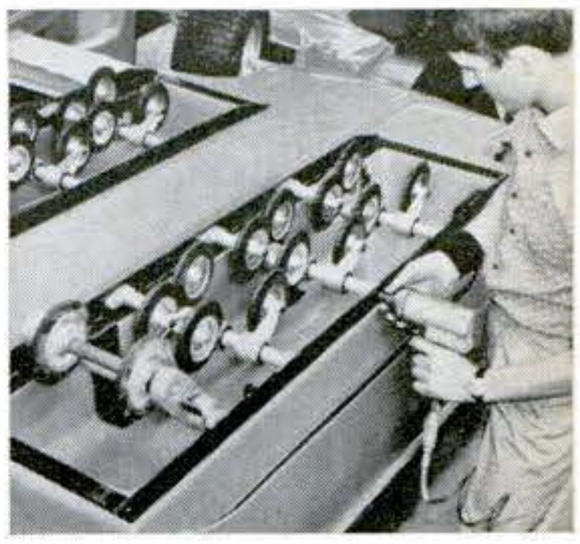
Modern-day campfire ➤

The heat's on, even if the power's off, with this new forced-air heater for campers. It runs on LP gas, pouring heat from its front grille without tapping battery power. In a campground where there's plenty of electric power you can turn on the blower. The 618 is made by Duo-Therm, LaGrange, Ind.



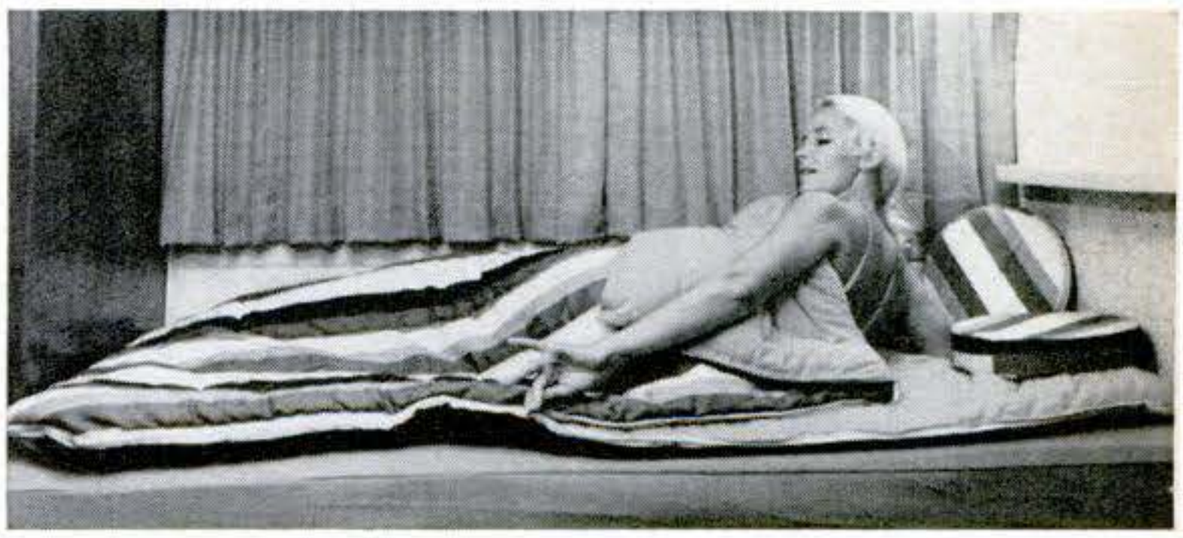
▲ Cool carrying case

Slip a pair of six packs into this foam-insulated case, pack in some ice, and you'll have cold drinks you can carry anywhere. Case is covered in hard plastic and locks shut when the two carrying handles are pressed together. The Swinger is made by Covey Corp., 8101 Carpenter Freeway, Dallas. $8.95.



The silent spring ▲

Twenty-four rubber springs cushion the ride of the Tracker ATV. B. F. Goodrich, which developed the springs, claims they won't squeak or rattle, will give a better ride, and are less likely to foul or clog with snow than the conventional steel type used on ATVs. They're extremely rugged, too.



Sleeping bags for indoor campers ▲

Bed making on camping trips not your bag? Then get into a sleeping bag. These lightweight Slumber Bags are especially designed for use in campers and trailers. Use them in place of normal sheets and blankets at night. In the morning you simply roll them up and they become attractive bed bolsters. The bags come in eight fabrics including stripes, plaids, and prints. All are machine washable, and dryable. They're made by Avion Coach Corp., 1300 East Empire Ave., Benton Harbor, Mich. 49022.

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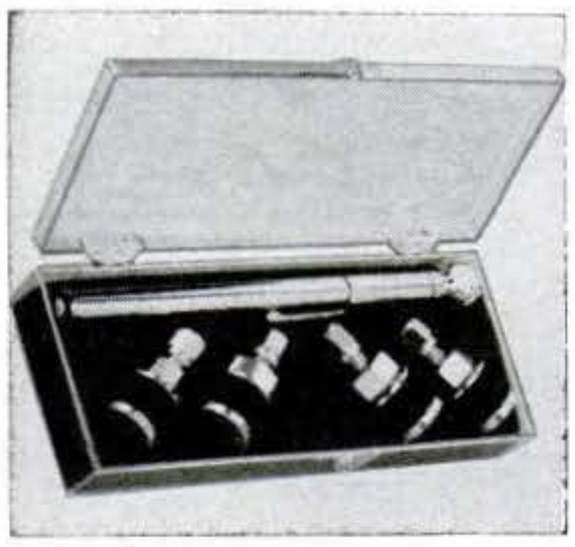
What's New
FOR YOUR CAR

Friend in need ↑

Out of gas? The Gasbag kit includes a fold-out distress sign (above), but more important: there's also a vinyl bag that will enable you to shift gas from another car that stops to offer assistance. It's $3.20 from Gasbag, 649 San Mateo Ave., San Bruno, Calif. 94066.

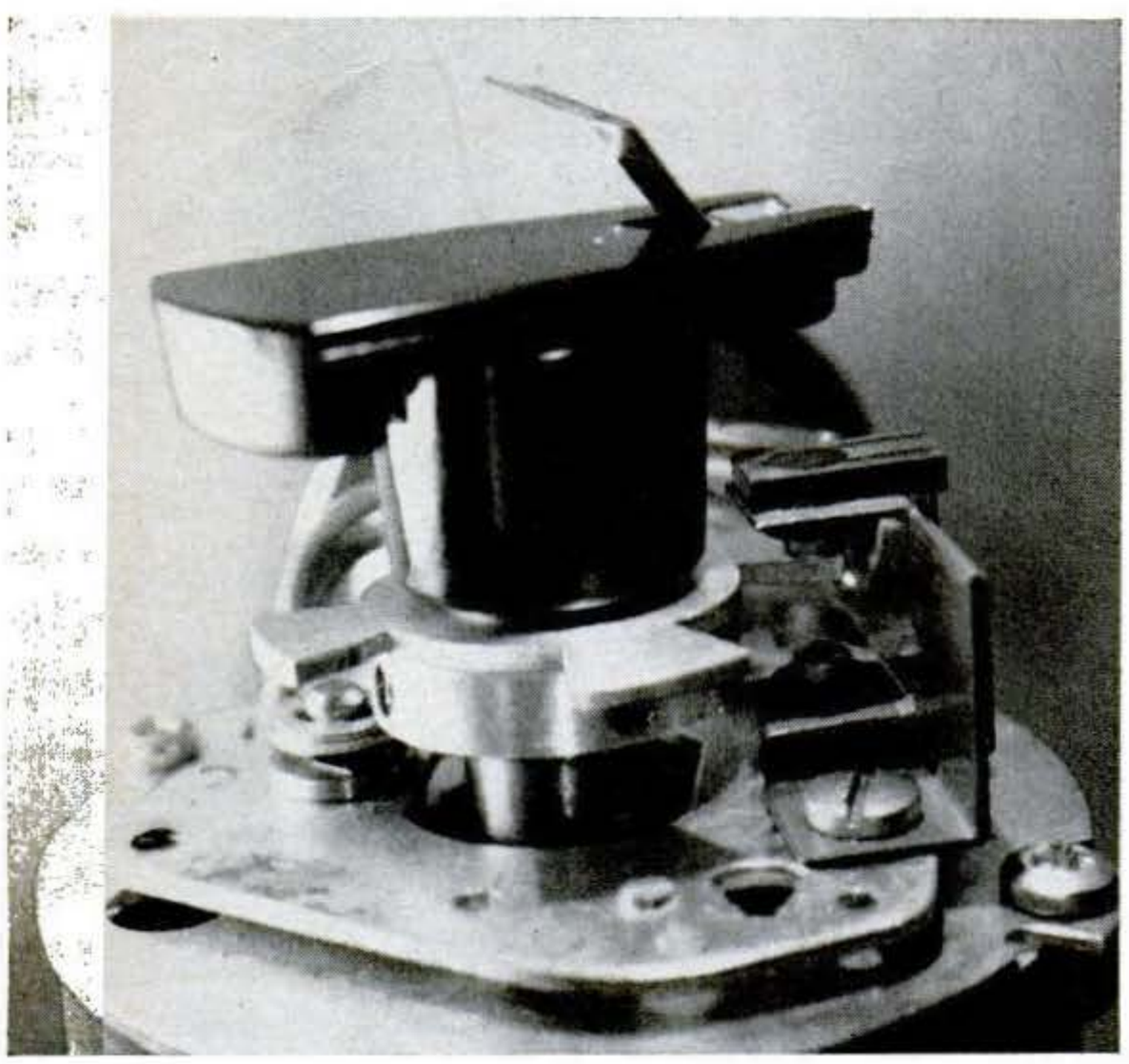
← Dragstrip shifting for the beetle?

Now you can get a Hurst shifter for your Volkswagen, whether it's a family sedan or a dune buggy. The stick has a patented Saf-T-Trigger giving positive reverse lockout. You can look forward to faster shifts with the shorter throw, too. The stick is copper-colored with a wood knob. The kit can be installed in minutes, using hand tools only. About $50 from authorized Hurst outlets.



Heavy duty ↑

High performance is what you get with the new Bridgeport 245 tire valves. They have a heavy baseplate and are secured by a tough hex nut (not located simply by the pressure on the rubber rim hole button). They maintain a positive seal against leaks, can't pop out of wheel. Bridgeport Brass, 30 Grand St., Bridgeport, Conn. 06602.



↑ Breakerless distributor

There are no points to clean or adjust in this new English distributor. It uses light from an infrared cell to trigger a phototransistor that works through a miniaturized electronic circuit. A power transistor switches the coil on and off to fire the plugs. Lumenition Ltd., 77-85 Newington Causeway, London SE 1.

↑ Quick disconnect

Here's a new easy way to rewire or hook up trailers. The Scotchlok 901 connector is solderless, and designed to receive male bullet connectors with diameters from .152 inch to .165 inch. Tap connections can be made to 14, 16, and 18 AWG solid or stranded wire. From 3M, Minneapolis, Minn.

What's New
IN BOATING

Up-tight meter ↑

You'll run a tight ship with the new Tension Meter on board. It measures the tension of stays and shrouds so you can tune the mast for optimum performance, avoid unnecessarily high tension that can even distort hull shapes. It's $19.95 from Lipton Marine, 22 Lafayette Ave., New Rochelle, N.Y. 10801.

Subsurface searcher ↑

Looking for fish? Heathkit's new fish finder will help. It can locate single fish or schools at depths down to 200 feet—and tell you a lot about the bottom, too. The MI-29 is completely portable, powered by batteries. It's $84.95 from the Heath Co., Benton Harbor, Mich. 49022.

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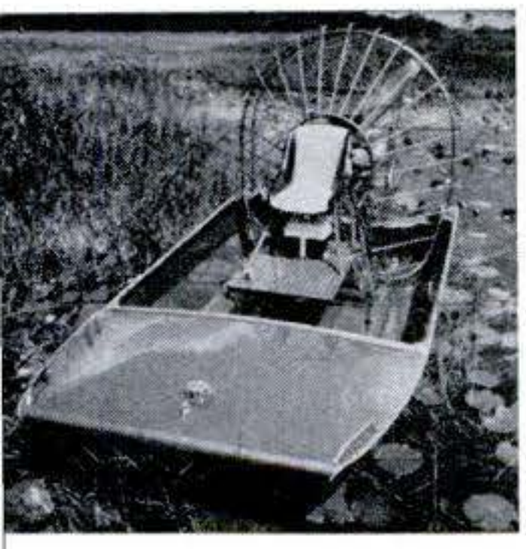
What's New
IN TOOLS

Folding fun afloat

car-top bundle four inches ick one minute, afloat with crew of four the next—that's e Fold-A-Boat runabout. lded flat, the 12-footer can hung on a garage wall for orage or easily car-topped small imports. Hull is in-wall aluminum with am flotation. Lonan Corp., alnut Creek, Calif. 94596.

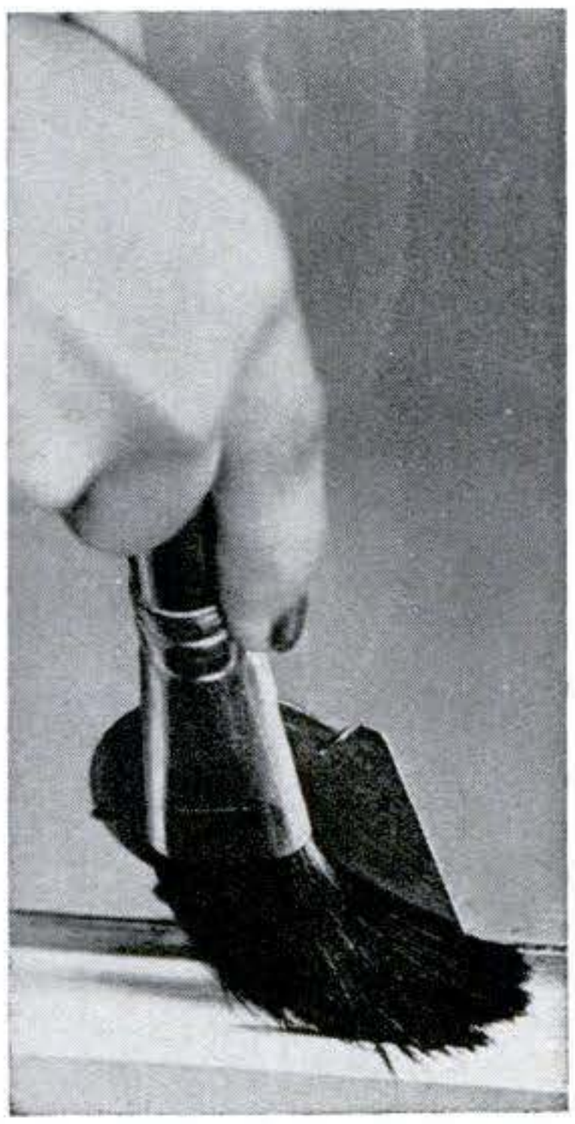
Bottom viewer

nses in the Water Scope ing up a wide view of the ttom at your favorite fish- g grounds, so you can locate e weeds, dropoffs, and ushpiles where fish gather. e 22-inch plastic scope llapses to 13 inches to fit ost tackle boxes. Waukegan utdoor Products, 4439 Grand e., Gurnee, Ill. 60013.



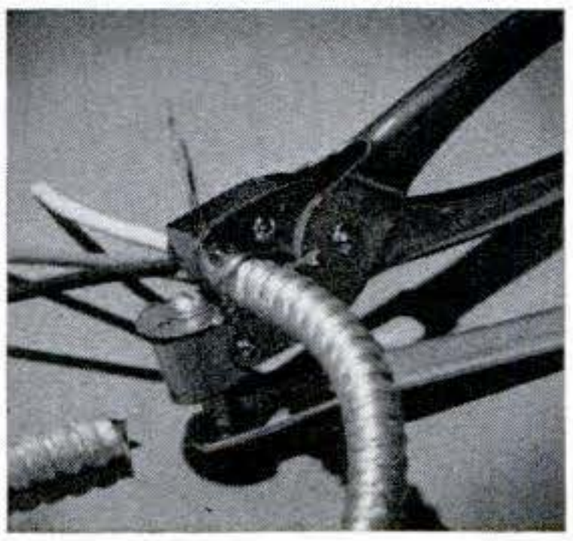
Swamp skimmers

eeds up to 60 mph and 180- gree turns at full throttle hat's the performance you t from a line of three new Gator aluminum air boats. wer comes from aircraft gines with 130-220 hp. The , 15-, and 18-footers are de by Mid Florida Alu- num, 1339 W. Washington , Orlando, Fla. 32805.



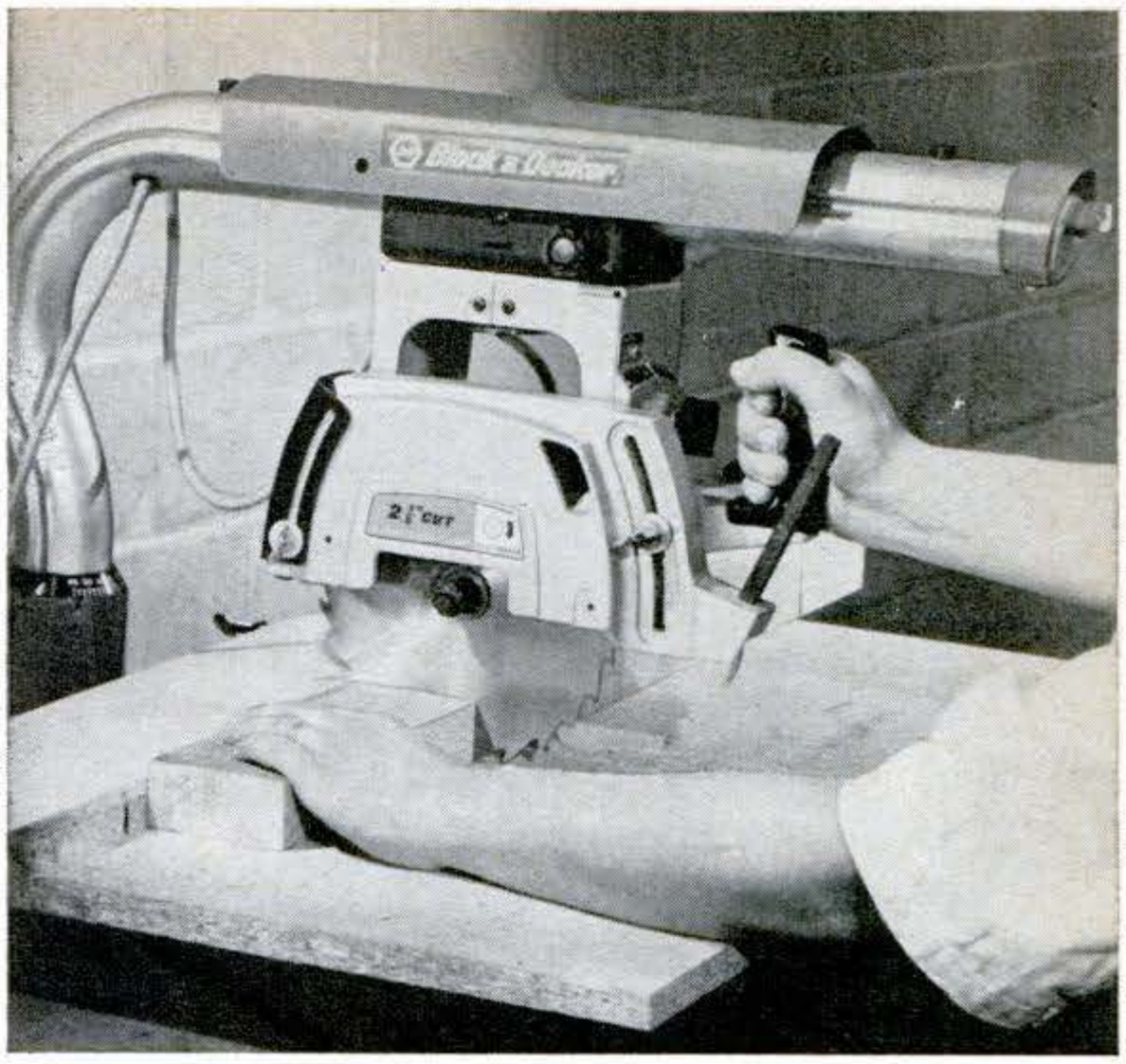
↑ Paint shield

Painting a neat edge along window sash or trim usually calls for masking tape. But this flexible guard can be attached to any size sash-and-trim brush to shield the area you don't want to paint. It retracts for dipping. Attached to a one-inch brush, it's $2.98 from Watro, 156 Muir Ave., Hazleton, Pa. 18201.



Cable stripper ↑

Ever try to saw through cable armor? You often damage the insulation and distort the cable. Not with this precision gripper-cutter of high-carbon steel. It strips BX Nos. 10, 12, and 14 in seconds, working in either direction, leaving no burrs. It's $8 from Cable Sheath Cutting Tool, Box 406, Kearny, N.J. 07032.

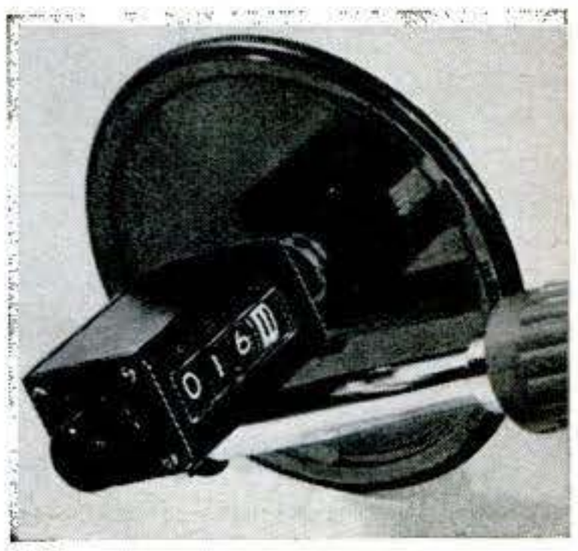


Would you believe a radial-arm saw for $100? ↑

If you've hesitated to make the hefty investment a top-brand radial arm involves, have a look at Black & Decker's No. 7700 eight-inch saw. Priced at $99.95, it's aimed specifically at the home-shop market, yet boasts the many features that have made this type of tool so popular: for safety, a key-operated switch at the front of the arm, plus a clutch to prevent motor burn-out; accurate settings and positive stops for basic woodworking cuts up to 2⅞" deep—including miters and bevels to 45 degrees, left or right. With a two-hp. universal motor and sturdy 22-by-32-inch chipboard table, it weighs only 58 pounds and can be carried to the worksite.

Walk-along rule ↑

Long or curved dimensions are clumsy to read with a tape or folding rule, as you've found when you tried to measure a room or twisting sidewalk. The odometer-type dial of this device accurately reads feet and inches as you roll the wheel along any path. Tapeless Rule by USM Corp. is $29.95 at hardware stores.



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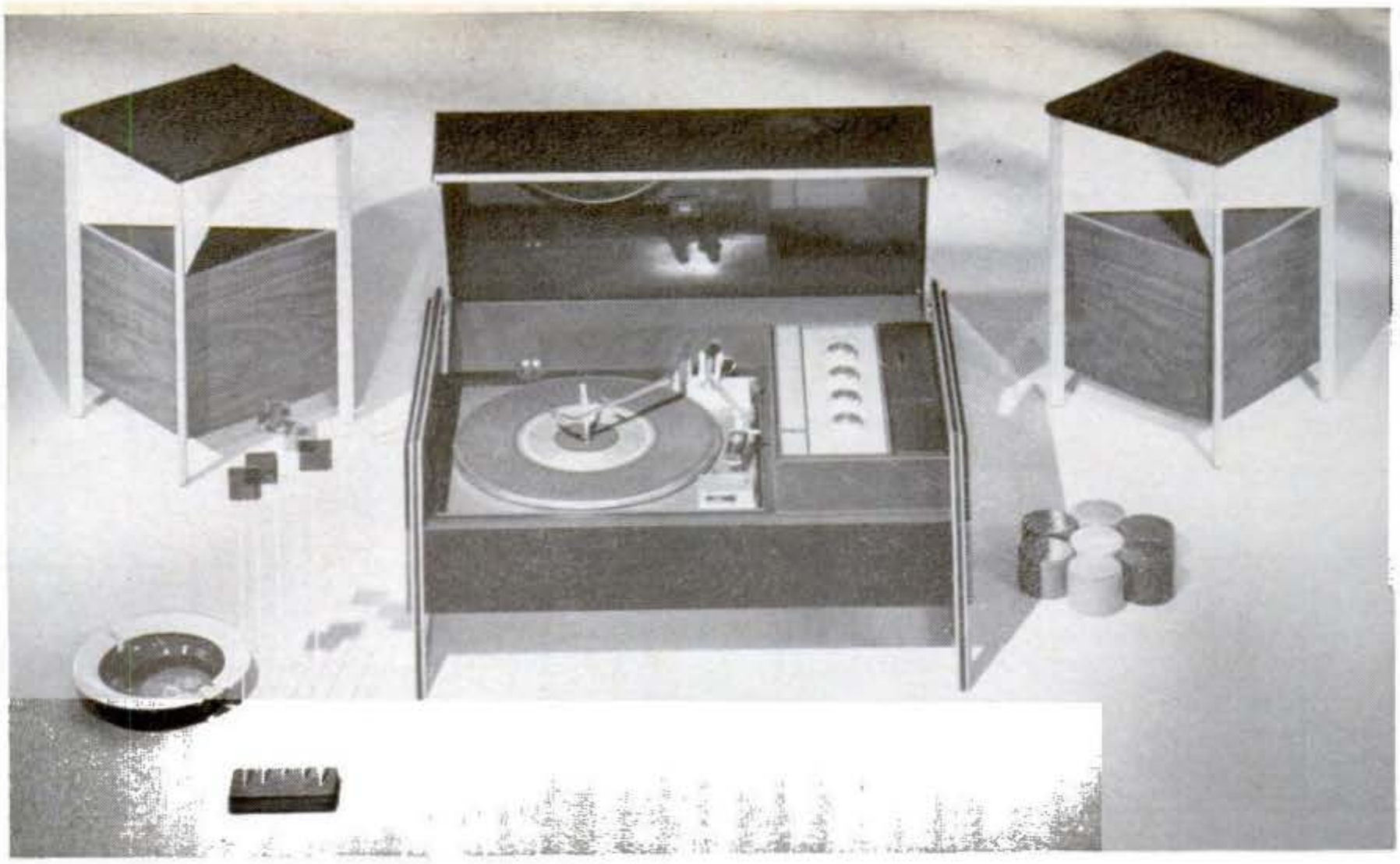
What's New
IN ELECTRONICS

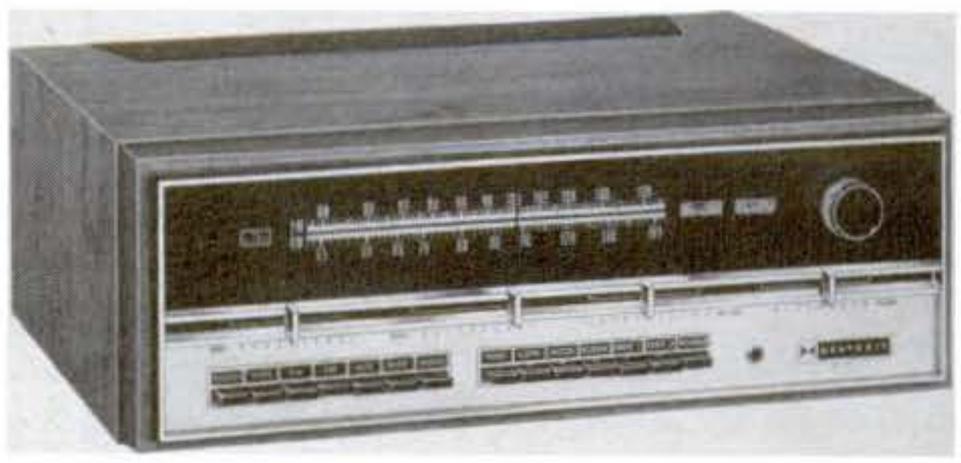
▲ Tell-all turntable

The new Miracord turntable doesn't keep any secrets. A built-in strobe indicator tells you how fast the platter's turning, and a stylus-wear indicator shows the hours of use the needle has accumulated. Among other features: pushbutton operation. The $200 770H is made by Benjamin Electronic Sound, Farmingdale, N.Y. 11735.



▲ Portable omni

Looking for a portable stereo AM/FM/phono unit to give you the new omni-directional sound? Look into the new RCA Dimensia IV. It includes tuner, turntable, and amplifier in the latest modular cabinet design, plus a pair of specially designed speakers that give full stereo effects no matter where you sit in a room.



▲ AM/FM stereo receiver analyzes itself

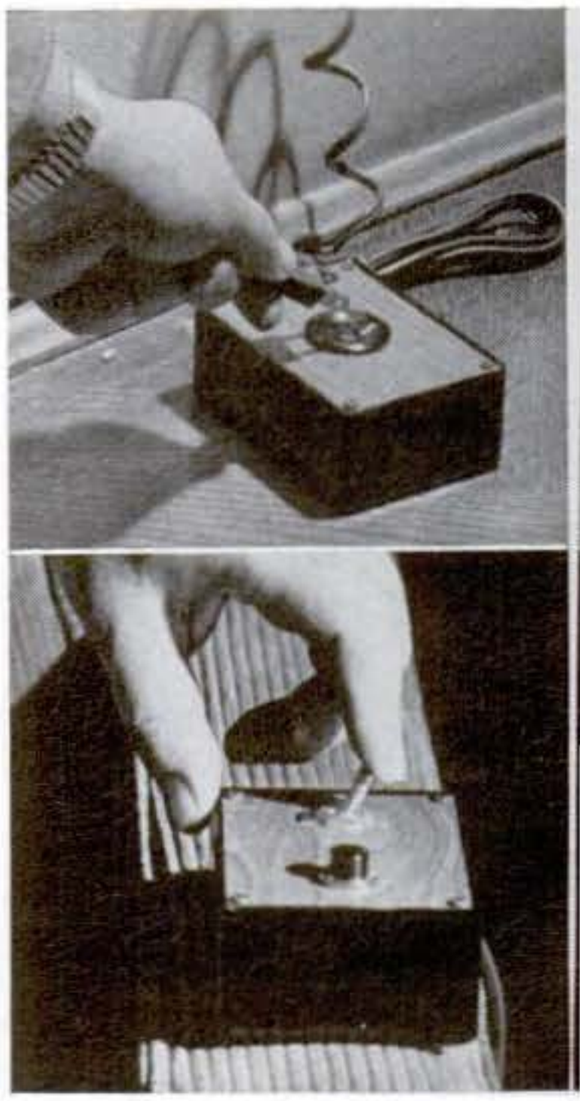
Plug-in circuit board and built-in test circuitry (including probes and meter) simplify the assembly of the Heathkit AR-29. Together, these two features let you check circuits both during assembly and afterwards, without extensive dismantling. The new 100-watt AM/FM stereo receiver is designed with performance in mind, too. It has a new computer-designed L-C IF filter that gives excellent separation and ends IF alignment. Styling? Linear-action controls replace knobs for tone, volume, and balance. Black Magic scales show no markings until power is on.

▲ Reversing recorder

Automatic reverse in half a second for both playback and record—that's what you get in Pioneer's T-600 four-track stereo tape deck. You also get a simplified threading system you can handle with one hand. The solid-state deck has two speeds: 7½ and 3¾ i.p.s. Slow speed gives you six hours of continuous playback or record.

Mini-speaker ➤

Bookshelf speakers are common enough, but here's one that fits on shelves for paperbacks. Only 6⅝ inches high and 4¼ inches deep, the Minimus can handle 10 watts through screw terminals or a phono jack. It has a walnut case with aluminum frame. $9.95 from Radio Shack.



Armchair servant ▲

Stay in your chair. You can turn appliances on or off anywhere in your house with this remote-control unit. A toggle switch on the transmitter (lower photo) sends your commands through the house wiring to a receiver that controls the appliance. It's $19.95 from Hazelton Scientific, Hazel Park, Mich.

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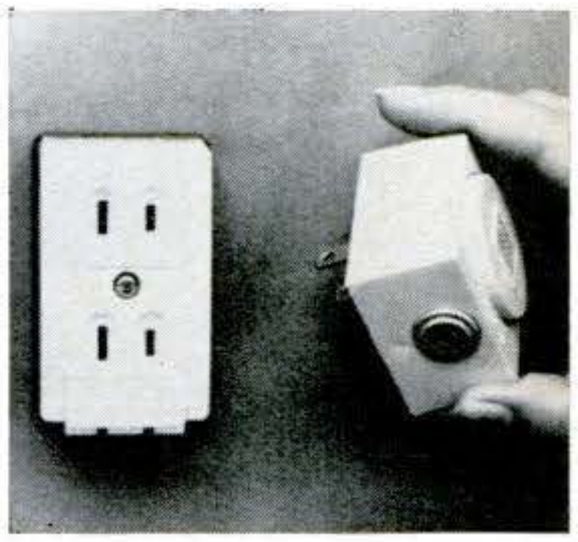
What's New
N HOME
MPROVEMENT

Silence panels ➤
Noise from this Ping-Pong game is dampened by a colorful array of panels on the walls. They're 1½-inch-thick fiberglass absorbers made by PPG Industries, kept a half-inch from the wall with prepunched mounting holes. The Colorsonix panels are under $6 in the 18-inch-square size and come in units up to 18 by 54 inches.

Lazy man's ice supply
u don't even have to open e door to the fridge: Your oice of cubes or crushed ice l drop into your glass when u press it against the cra- of a custom dispenser lt into new side-by-side rigerators. It's on the out- e of the freezer door, sup- ed by an icemaker that res up to 260 cubes. From this spring.

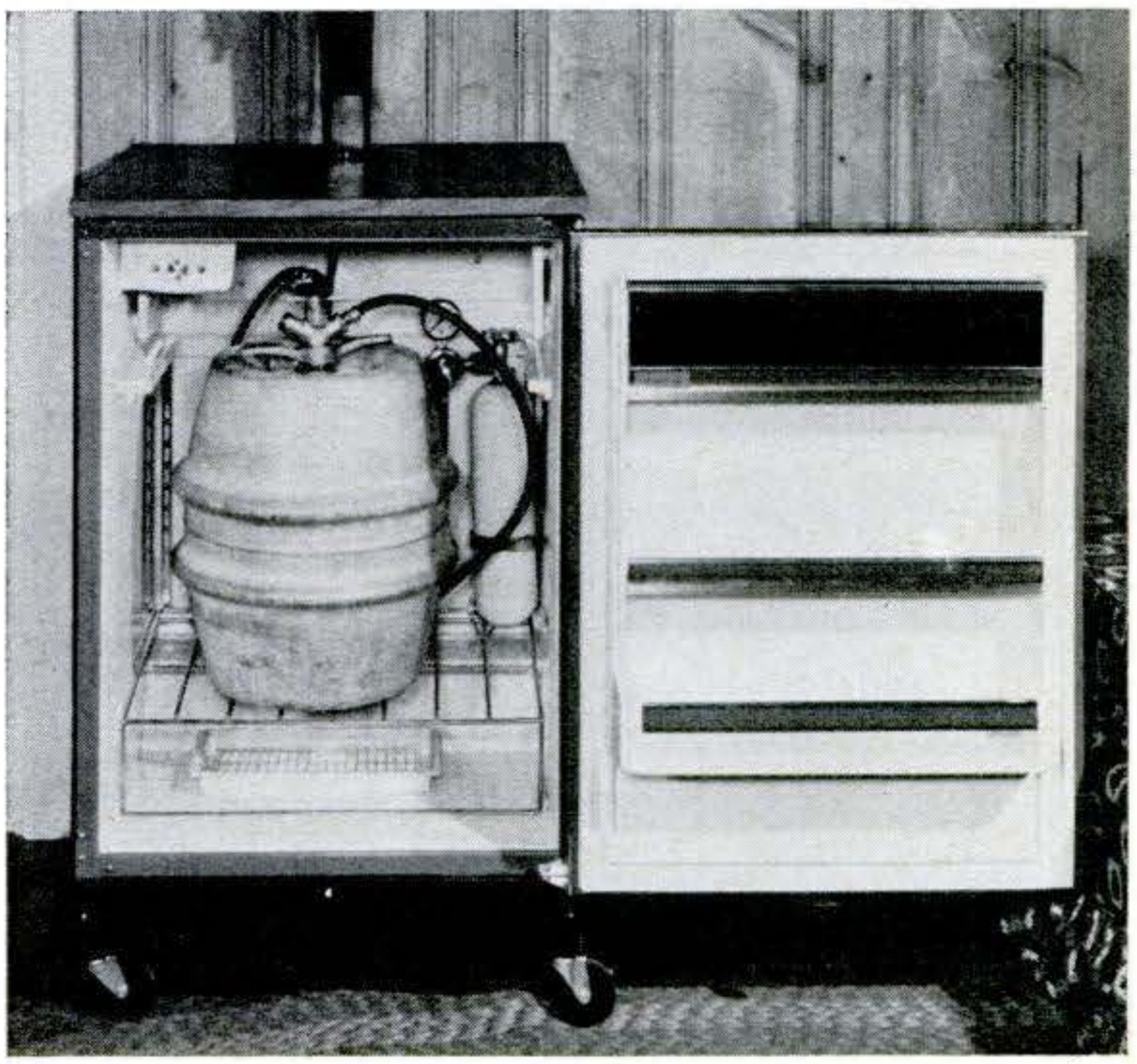
Bladeless fan ▲
It's safe for this youngster to help with the dusting—the fan is a prototype of a newly patented design that utilizes the Venturi principle of air flow to eliminate spinning blades in cooling or heating units. It's by Product Promotions and Development, 80 Boylston St., Boston, Mass.

Zodiac carpet ▲
Astrological signs in your carpet? Why not? All you need are a sharp knife and contrasting colors of a self-stick indoor-outdoor carpet tile such as Armstrong's Wearathon. Instructions and designs for all 12 symbols are free from Zodiac Patterns, Lancaster, Pa. 17604. Insets are easy to cut and lay.



Plug-in fire alarm ▲
You can't get more compact protection than this early-warning system that plugs into any wall outlet. A sensor activates a loud buzzer when room temperature reaches 135 degrees. The three-ounce alarm comes in a traveling case for use away from home. It's $9.50 from Lucas Enterprises, 8806 Hendon, Houston.

Ah! Real draft beer from a converted refrigerator ➤
Here's a small refrigerator destined for big things. Though it's a regular Coldspot with 6.6-cubic-foot capacity, automatic defrost, a 16-quart crisper, egg tray, and standard shelves, it's really intended for conversion into a draft-beer dispenser—a job that takes about a half-hour. The unit will hold a quarter-barrel keg and comes with a beer-dispensing kit that includes the walnut-finish countertop, draft arm, air and beer lines, and a fully charged 2½-pound CO_2 bottle. Three different kits accommodate all types of brewers' kegs. Next month, from Sears.



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Motorized Cover Rolls Over Swimming Pool

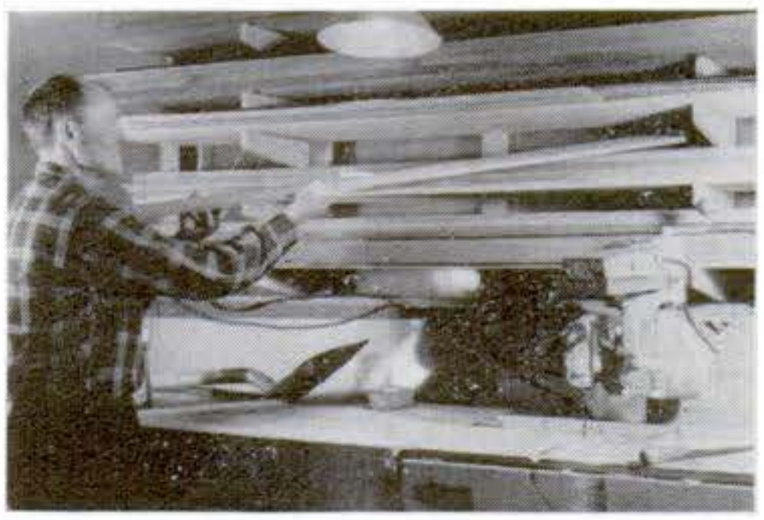
By HENRY F. UNGER

At the flip of a switch a terrace rolls out to cover Glenn Trainor's pool in Phoenix, Ariz. In place over the water (photo below), the terrace is more effective than a fence in preventing access to would-be swimmers when no one is home to supervise.

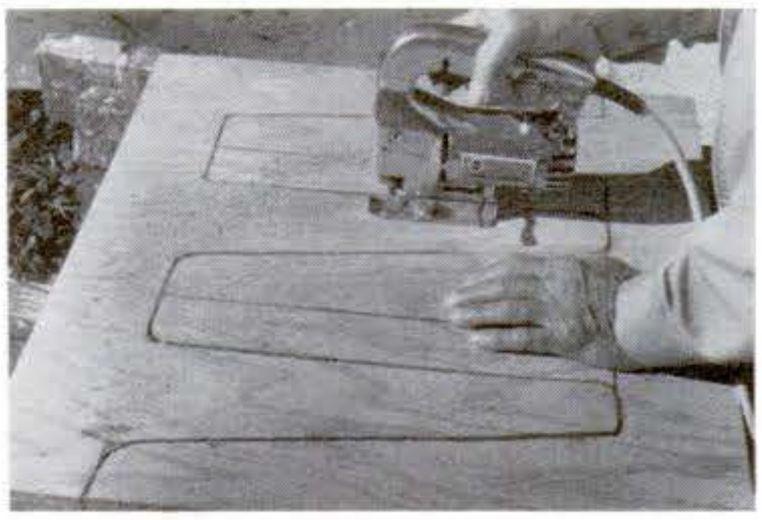
Trainor's deck is constructed of wood planking over a steel frame, but an all-wood design would work as well. All the work of moving the cover is done by a one-hp. electric motor, which chain-drives one of the four wheels that the deck rolls on. Gears reduce the speed, and a reversing switch permits two-way movement. A concrete track along one edge of the pool guides the rolling deck.

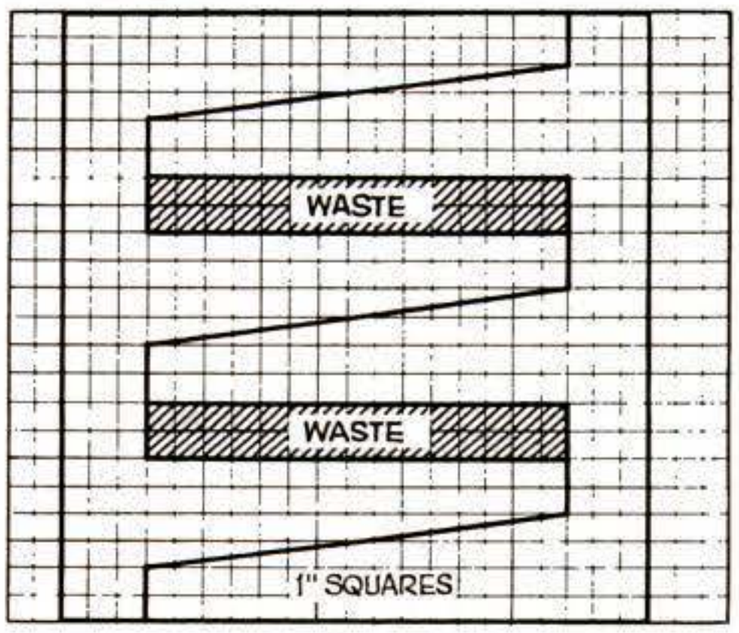
Since the motor makes covering and uncovering so easy, Trainor usually keeps the pool covered when it's not in use. He claims this has cut pool maintenance over 50 percent.

Trick Way to Cut Shelf Supports



Cantilevered plywood brackets make ideal racks for shop and garage storage of lumber. You can use them to support shelves, too, to store paints and hardware; or with wider-spaced fingers to store larger items.





Lay out a rectangle of ¾" plywood as shown in the diagram and saber-saw on the lines. Pattern shown results in very little waste. The cantilever design takes full advantage of plywood's inherent strength.

Nail supports to the sides of studs in your shop or garage, making sure that you keep the pairs at the same height. If the supports are temporary, use duplex nails and you'll be able to take them down easily.

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ELECTRONIC STETHOSCOPE probes the unhearable

Make the black box wired to the receiver at right and you can monitor phone calls as a group. Other accessories let you check out auto and outboard engines, trace wiring, isolate TV interference

By RUDOLF F. GRAF
and GEORGE J. WHALEN

Nature, in planning the human body, positioned the ears so they were relatively well protected—but not quite as useful as they might be. Nature, of course, never intended man to use his ears for troubleshooting automobile engines, rotating machinery, or shop tools. Yet, with a helpful boost, your ears can probe the inner workings of anything that moves, vibrates, or produces electrostatic or electromagnetic fields.

The boost? An electronic stethoscope that you can make in a weekend. It's a device that lets you analyze the operation of engines without fear of burns or injury from rotating parts. In addition, the stethoscope can be used to help you hear things not normally audible.

Our stethoscope is a multiple-purpose instrument consisting of a sensitive solid-state amplifier and a variety of matching plug-in pickups. These pickups transform mechanical vibration, electrostatic or magnetic fields, acoustical pressure, and electrical signals into the audible range, thus permitting your ears to work in close conjunction with your hands in locating and analyzing trouble spots.

How it works. The heart of the device is a prefabricated solid-state audio-amplifier module, available from Lafayette Radio Corp.—at a price well below the cost of the components required to duplicate it. To this basic amplifier module, we add a specialized solid-state preamplifier; this provides the various pickups with additional amplification and impedance matching. The audio amplifier is capable of delivering 360 milliwatts of audio output to the self-contained miniature speaker—or to a pair of headphones you can wear when the background noise is great enough to over-ride the signals from the speaker.

A separate module is used for the pre-amp. This circuit is assembled on a perf board and consists of a PNP transistor that can be switched to provide high or low input impedances to match the pickups. Sections A, B, and C of S1 accomplish this change. In the high position, this switch arranges the preamplifier as an emitter-follower stage. In the low position, the switch changes the circuit to that of a common emitter figuration.

Thus, at HI it's possible to utilize the output of a crystal-type pickup used in mikes and phono cartridges. At LO, the circuit is usable with a magnetic or variable reluctance pickup. A pair of nine-volt batteries supply the power, so the unit is self-contained. The pair is connected in parallel, which provides reserve current to assure that the output of the stethoscope faithfully reproduces the signal energy from the pickups.

The four pickups. You will need a crystal phonograph cartridge to make the *vibration pickup*. It's installed in an aluminum case on a pair of spacers that are centered to fit into existing holes in the cartridge. A hole drilled opposite the thumbscrew of the phono pickup lets you insert a snip of coat-hanger wire, which fastens into the stylus socket. (The screw itself—snugged tight—can serve as the contact instead, where more convenient.)

A shielded lead is connected to the terminals of the pickup. (Use only vinyl-jacket cable for the four leads. The phone plugs are Switchcraft type 750.) Use the clips supplied with the pickup, rather than attempting to solder directly to the terminals, for the heat could destroy the crystal. The rod "feeler" extends the reach of the pickup into cramped quarters and heightens sensitivity to higher frequencies. A tip of heat-shrinkable

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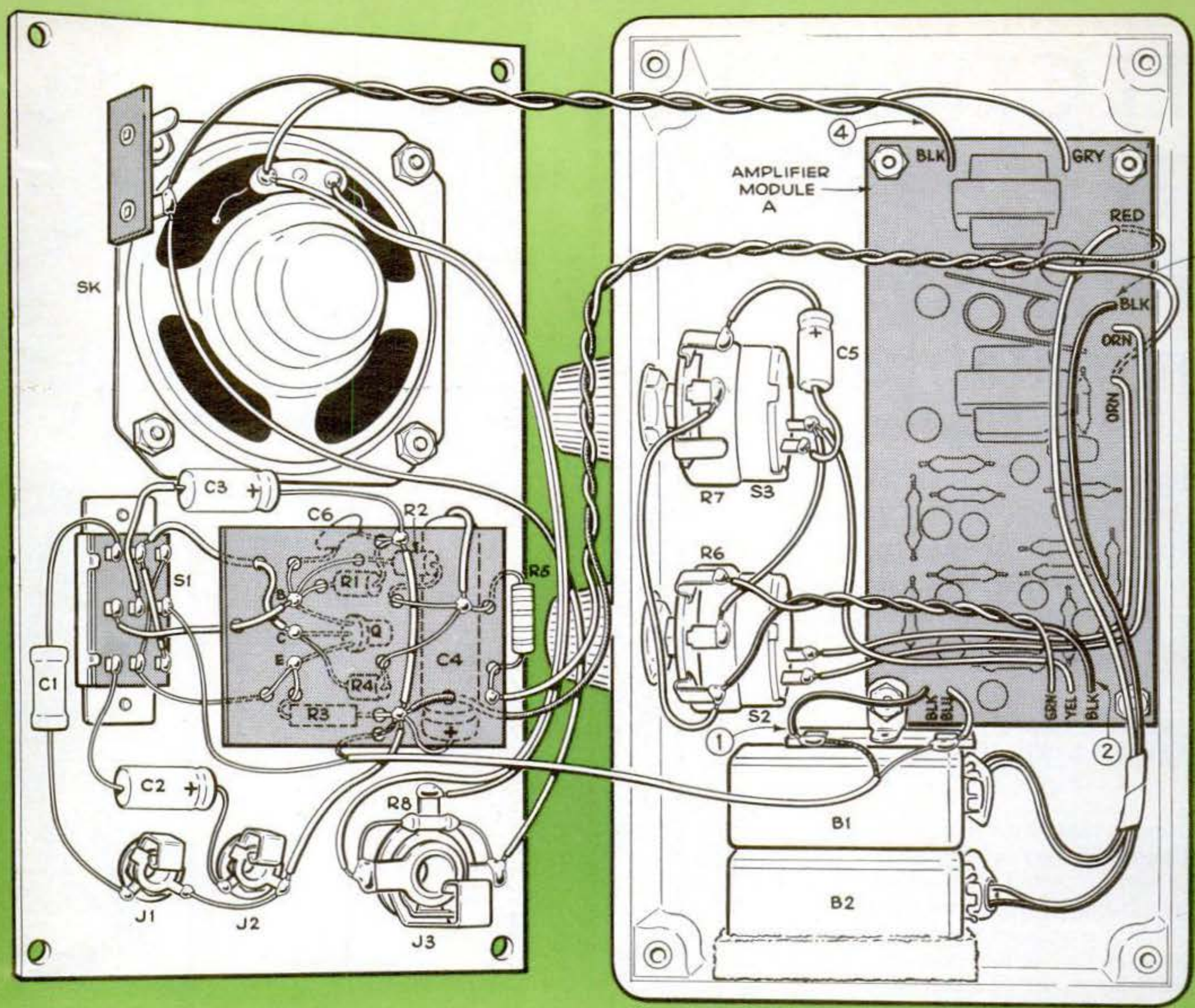


VOLTAGE AND RESISTANCE CHECK

From	To	Volts DC	Resistance Ohms
Q-E		−3.75±0.2	1,800
Q-B		−4.25±0.2	22,000
Q-C		−4.40±0.2	8,000
BLK(1)		0	0
BLU		−3.75	1,800
GRN	B1/B2 (+)RED)	0	4,500 ±500
YEL		0	470,000*
BLK(2)		0	0
ORN (both)		−8.2±0.5	7,000
BLK(3)		−8.2±0.5	7,000
BLK(4)		0	0
GRY		0	<1

NOTES:

All readings taken with 100,000-ohms/volt multimeter (Lafayette, type 99-5065).

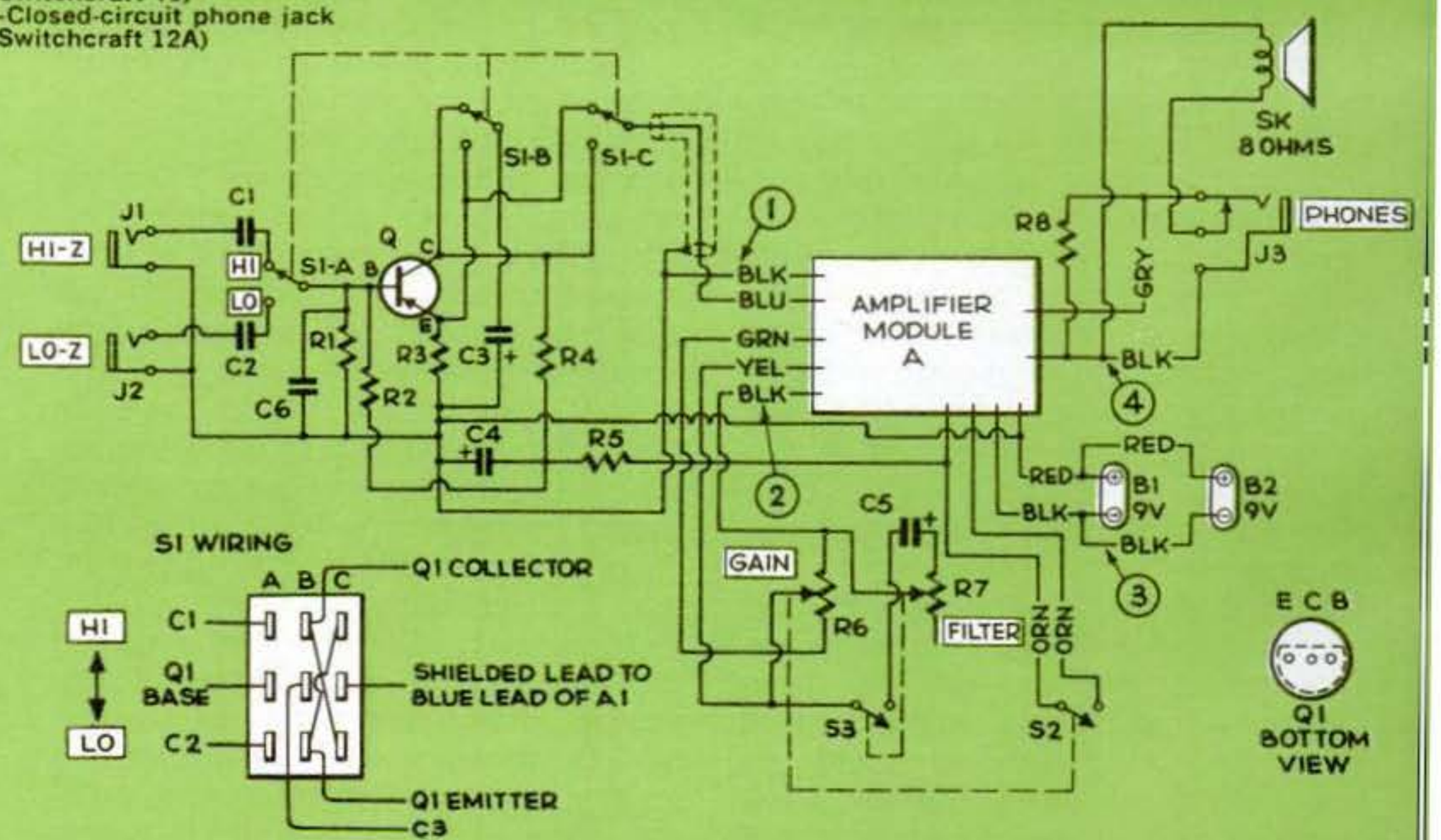
Voltage readings made with (+) probe connected to B1/B2 (+) (RED) lead, S1 on, S2 off, gain control R6 at minimum setting.

Resistance readings made with B1/B2 disconnected, (+) probe connected to B1/B2 (+) (RED) lead, S1 on, S2 off, gain control R6 at minimum setting.

*Reading taken at RX 100k setting.

PARTS LIST (NOT INCLUDING PICKUPS)

A—Miniature transistor amplifier (Lafayette 99T9037)
B1, B2—9v alkaline battery (Mallory MN-1604)
C1—0.1 UFD, 200v
C2—1 UFD, 50v electrolytic
C3, C5—30 UFD, 16v electrolytic
C4—390 UFD, 12v electrolytic
C6—0.01 UFD, 150v ceramic
J1, J2—Open-circuit phone jack (Switchcraft 41)
J3—Closed-circuit phone jack (Switchcraft 12A)
Q—PNP silicon transistor (GE D29A4)
R1—22k ½w ± 10%
R2—68k ½w ± 10%
R3—1.8k ½w ± 10%
R4—1k ½w ± 10%
R5—560-ohm ½w ± 10%
R6, R7—5,000-ohm linear taper potentiometer (Mallory U-12)
R8—33-ohm ½w ± 10%
S1—TPDT slide switch (Lafayette 99T6166)
S2, S3—SPST switch (Mallory US-26)
SK—8-ohm 1w 2¼"-dia. speaker (Lafayette 99T6037)
Misc.—Bakelite meter case (Lafayette 99T2001), panel (Lafayette 99T370), battery clip, knobs, nuts, wire, etc.



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tubing cushions against metal-to-metal-contact static.

The field pickup is a telephone induction coil of the type that's used with miniature tape recorders. This coil converts magnetic fields associated with alternating current (or with circuits that make and break, as in DC motors and generators) into audio voltage which can be amplified.

The acoustical pickup is a dynamic cartridge of the type used in subminiature microphones, assembled in a tiny plastic box lined with polyurethane sponge. A shielded lead is attached to the cartridge terminals. A bit of double-faced tape is stuck on back of the mike, over these leads, and pressed firmly onto the sponge. This cushions the cartridge from excess vibration.

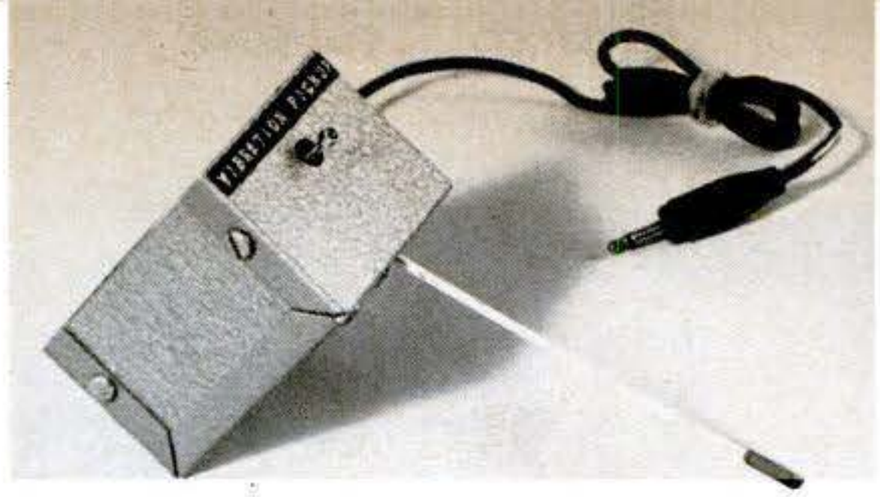
The capacitance pickup is made by stripping the plugless end of the shielded cable for three inches. Connect the center conductor to a small .001-MFD 400-VDC Mylar capacitor (Sprague part 192P10204). Solder the other end of the capacitor to a snip of coat-hanger wire and insert this assembly into the body of an old felt-tip marker, for insulation. You can leave the shield braid floating, as shown, or ground it with a clip lead.

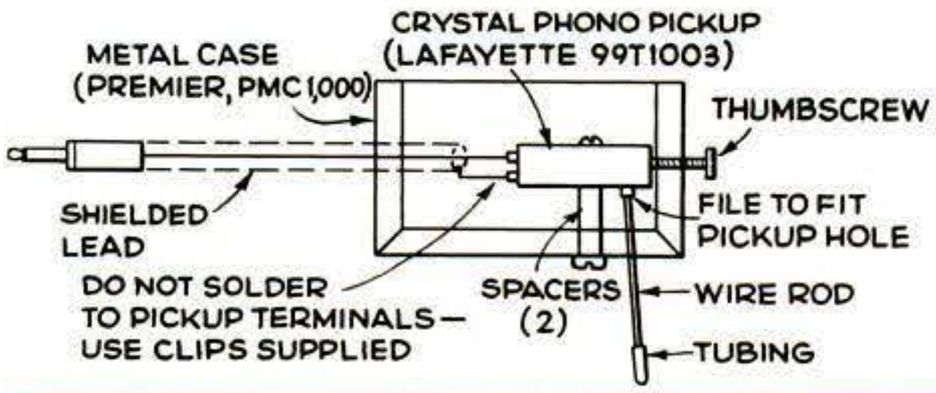
Using the stethoscope. As our chart shows, the four pickups serve different functions. The first detects vibration or odd noises in your car's engine, generator, starting motor, transmission, and other areas. You can isolate sticky valves by listening for the hiss and clank. Worn brushes in DC generators or arcing in a spark coil will appear as a ragged sound, rather than the normal steady whine.

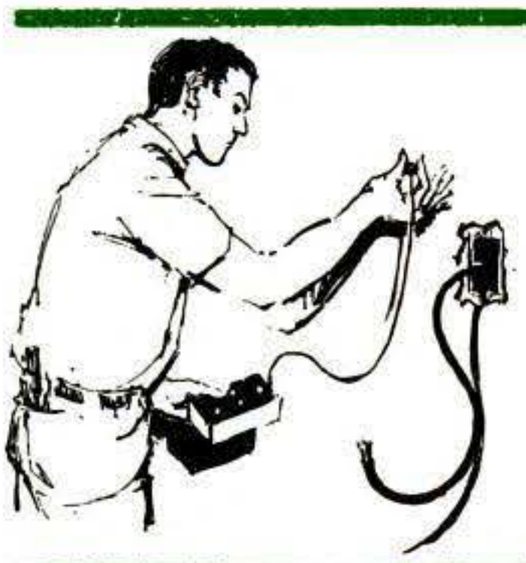
With the field pickup you can trace wiring in your walls. Energize the circuit (just plug in a high-watt lamp) so the current flow generates an AC field. Run the pickup along the wall until the stethoscope speaker emits a loud 60-cycle hum. The field pickup can also be used to monitor telephone conversations, either directly from the phone wire or by attaching the suction cup over the receiver, or at the side as shown in our sketch on page 99.

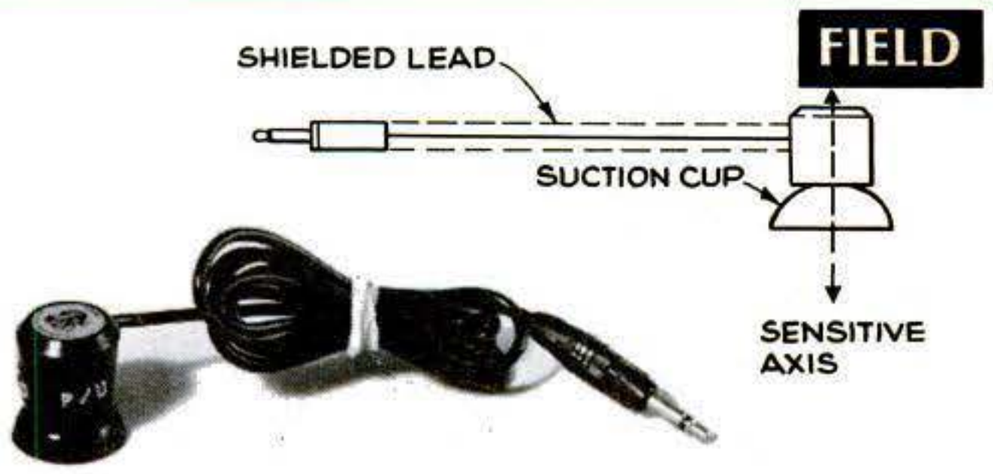
The acoustical pickup will supplement the vibration pickup, since it doesn't need to contact the test unit.

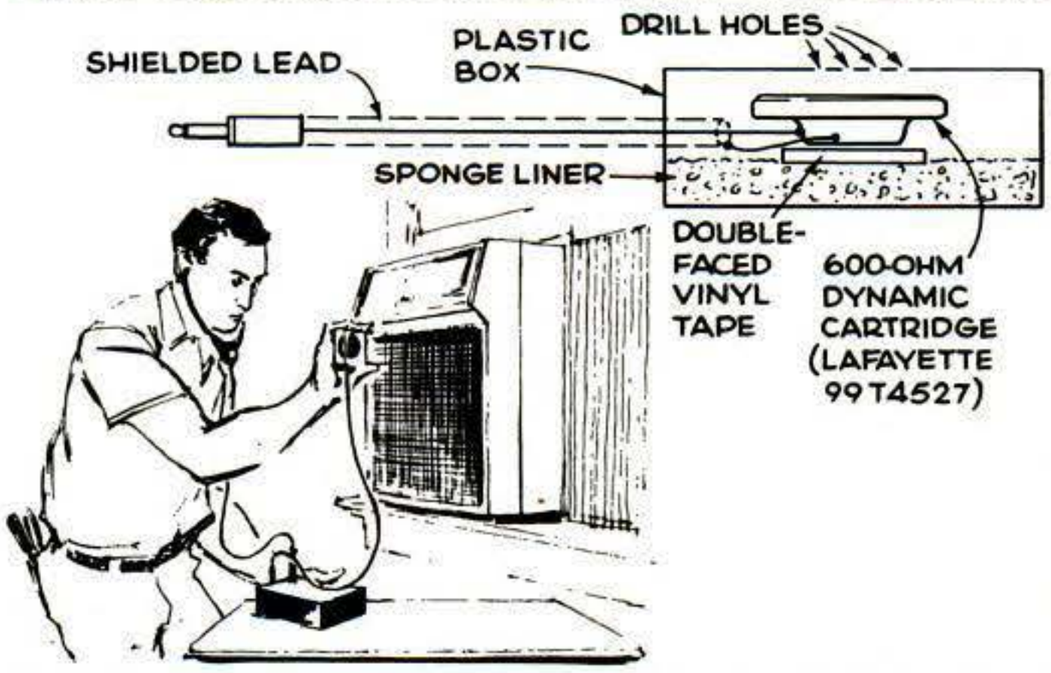
The capacitance pickup lets you detect the presence of point bounce at the distributor by listening to the pulses while the engine is operating. When you apply the probe to the primary lead of the spark coil, a regular clicking indicates proper operation. (Don't use on high-voltage wiring.) This pickup also lets you isolate sources of radio and TV interference, such as sewing machines, appliances, or thermostatically operated devices. Just sense around the line cords to find the unit that's causing the trouble. PS

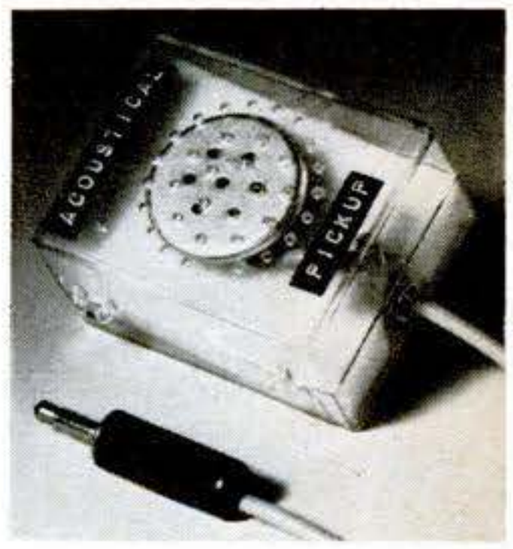


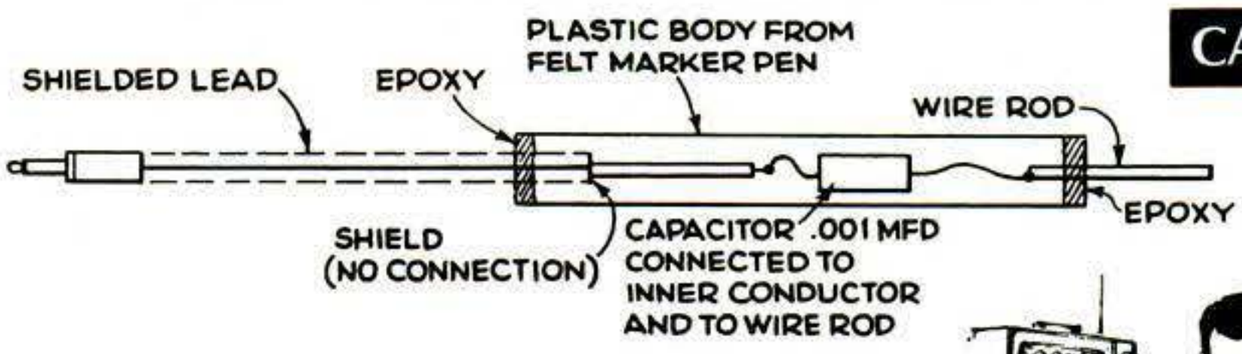


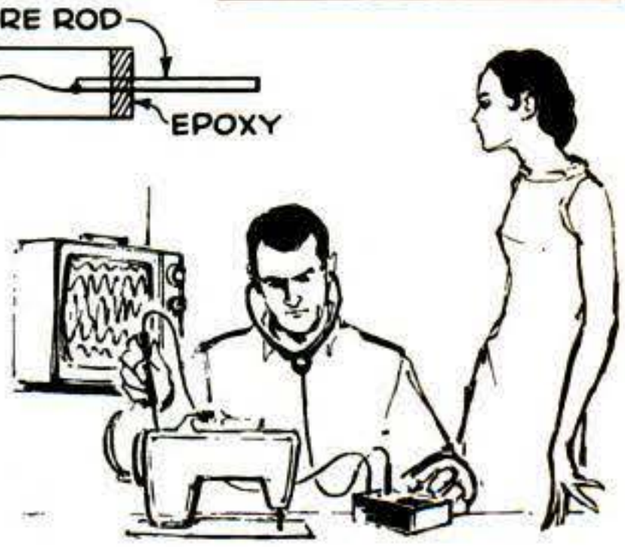












HOW TO USE THE FOUR PICKUPS

Type	Coupling Method	Input Terminal	Switch Setting	Application
Vibration	direct contact	HI-Z	HI	automobiles, motorcycles, boats, home appliances, power tools, machinery
Field	electromagnetic field	LO-Z	LO	motors, generators, alternators, power lines, telephone pickup, hum trace
Acoustical	air	LO-Z	LO	similar to vibration, but without need for direct contact
Capacitance	electrostatic field	HI-Z	HI	detects electrical switching-action arcing, sparking, corona, and insulation breakdown

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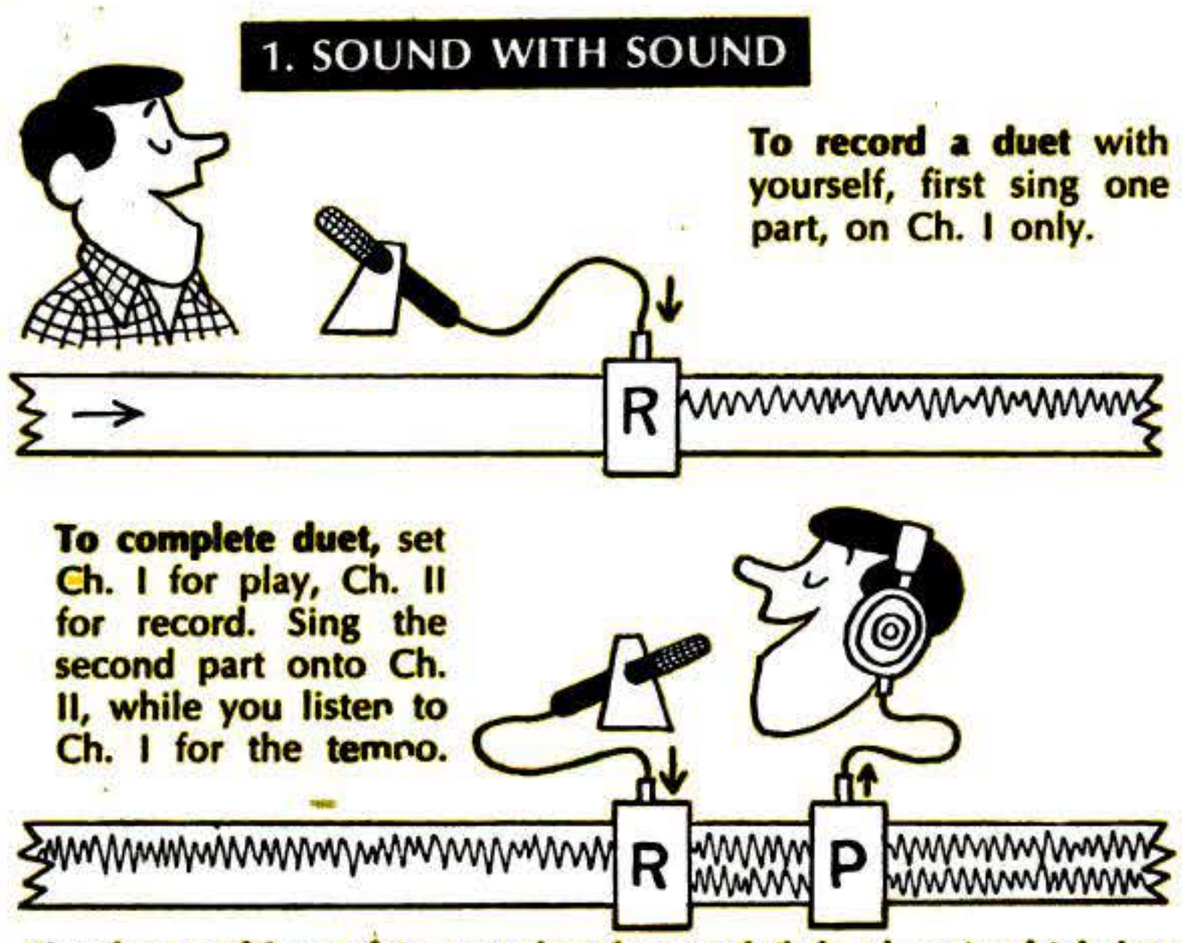
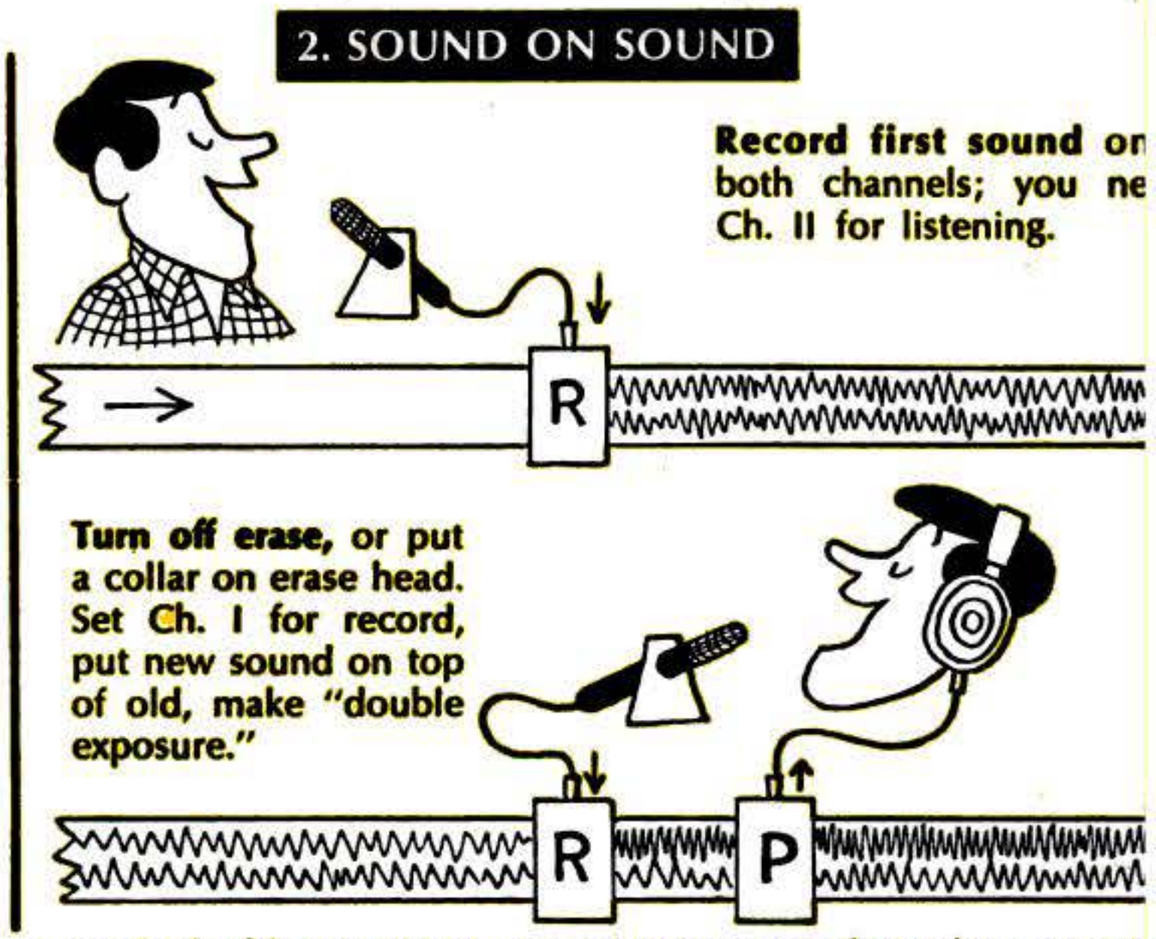




Simplest multisound is sound-with-sound (left, above) which lets you combine two sounds, one on each stereo track. Sound-on-sound (double exposure) can put two on each track; you swi off erase, or put film collar on erase head to prevent erasu

MULTIPLYING SOUND WITH A TAPE RECORDER

You and a couple of friends can make music that sounds like an entire orchestra

By ROBIN LANIER

ILLUSTRATION BY ROY DOTY

Would you get a kick from a tape recording of a male quartet in which one person (maybe you) sings two, three, even all four parts? Or a recording in which you and two friends become a huge, shouting crowd in a tense drama?

Or maybe you'd like to astound your friends by playing a piano duet —you and Artur Rubinstein.

You can do any of these things—and others equally startling—with one or another form of "multisound," a recording technique that any owner of a moderately sophisticated home-style stereo machine can use.

What you need. You must have a machine with separate controls for the two channels, so you can operate with one channel in record mode and the other in play mode. A majority of home stereo machines above the small portable level, including many of the new cassette recorders, have that.

Say you want to sing a duet with yourself. Use "sound with sound."

If you have a three-head machine, the time lag between record and play (about a quarter of a second with the heads two inches apart, at 7½ inches per second) will make it confusing to listen to the right channel as you sing into it. Slip the right headphone off your ear; listen only with the left.

That same lag means that you should not lag behind yourself in singing the second part—you are already a little late when you hear yourself. The built-in lag will not be great enough to be objectionable.

To get the two you's in balance for loudness, try to match volume-indicator readings on the second pass to those you hit on the first. After 20 seconds or so of the second pass, rewind and listen to what you've got. Adjust recording controls, if necessary, and try again. You can give the balance a final touch-up in playback with the balance control on your tape recorder or amplifier.

When you listen to the finished tape you can have one voice from one speaker and one from the other; or you can play in the A-plus-B mode (if you have a switch for that) and put the two together in the middle.

A double exposure. The second technique is sound on sound. You record one sound, then go back and put another right on top of it on the same channel with the erase off.

You must record at a high level, because putting on the second sound will push the first one down a bit. Make a trial section of the first sound before running through.

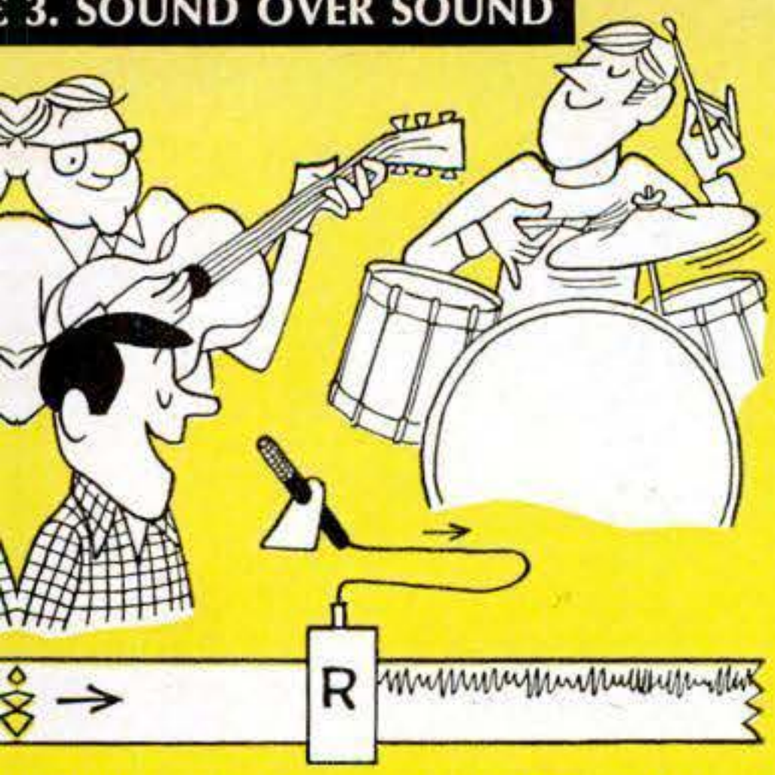
On the second pass, record 20 seconds or so and rewind to listen for loudness balance, using part of the trial section. Adjust controls and use another 20 seconds of the trial run; repeat until you get the two sounds balanced. Then make your recording on the complete run-through.

As before, don't try to listen to the channel you are recording while you do it. That lag between the record head and the play head can produce an unnerving, confusing effect.

Now for the big ride. Having tasted the fun, you are rarin' to go on the multiplier effect, bringing in the third technique, "sound over sound." You decide to aim for four singing parts and a small orchestra of eight parts. You recruit two friends who can double in brass—one plays trombone, trumpet, and guitar, the other sax, drums, piano. You have, or work up, an arrangement with first and second sax, first and second trombone, piano, trumpet, guitar, and drums. With your four voice parts, that totals 12.

[*Continued on page 146*]

E 3. SOUND OVER SOUND



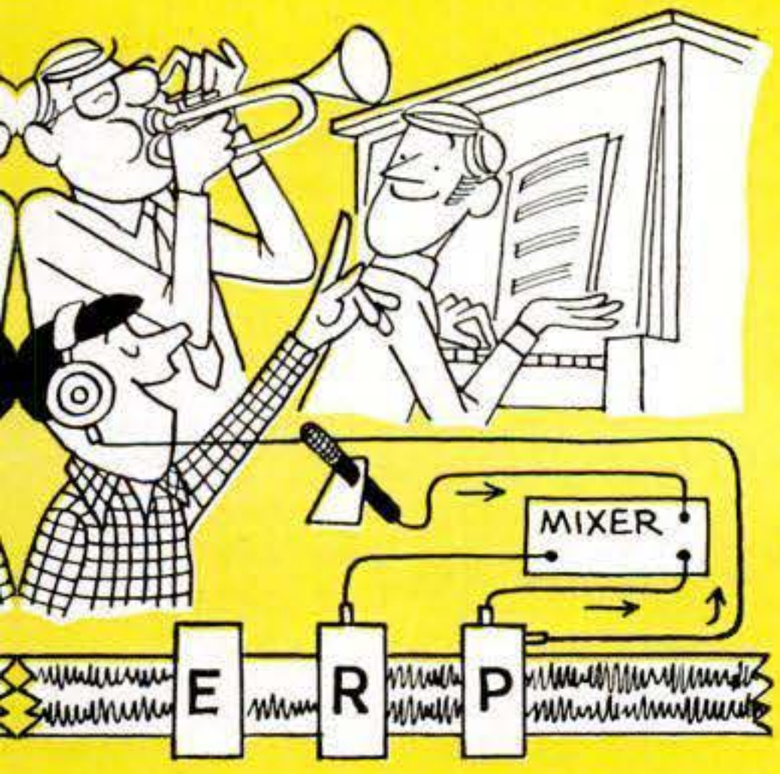
Here's how to turn yourself and two friends into a 12-man group, making music together. First: You sing first voice part, friend A plays guitar, friend B drums. Record trio on Ch. I. It will set tempo for the rest.

Only equipment needed for first two kinds of multisound is stereo tape machine with separate controls for two channels, phones, mike. Add small mixer for sound over sound.

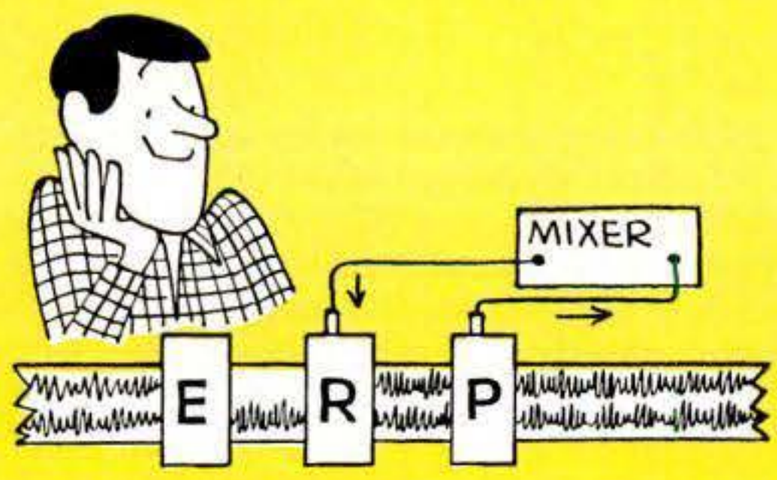
Second: Set Ch. I for play, and connect output to mixer. Connect mike to second mixer input. Set Ch. II for record, and feed mixer output to it. You can mix trio recorded on Ch. I with new trio—you in second voice part, friend A on trombone, B on sax. Phones let you lead; sextet on Ch. II.

Fourth: Reverse channels again, setting I for play, II for record. Sing fourth part, as friend A plays second trombone, B second sax. Balance this trio with nine parts on Ch. I, record all 12 onto Ch. II, replacing six left there, leaving nine on Ch. I.

Final combo has first and second sax, first and second trombone, guitar, drums, trumpet, piano, four voices. Text gives additional points in technique, suggests other uses for three kinds of multisound.



Third: Reverse channel connections, setting I for record, II for play. Sing third part, as A plays trumpet, B piano. Balance new trio with sextet on Ch. II, put all nine on Ch. I, replacing trio that was left there.



Last: Make a balancing pass, with output of Ch. II (12 parts) fed across into Ch. I to replace the nine there. Result is a mono recording, the same 12 parts on both sides. Text describes variation for stereo.

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You don't need musical talent to follow these procedures. Just match the tone that comes from the tool to a source of known pitch.

How to Tune In on RPMs

Check the pitch of a revolving shaft and you have a good clue to its speed

FREQUENCIES OF MUSICAL NOTES

	Musical note	Frequency in cycles per second (Hz.)*	Frequency in cycles per minute
	A	220	13,200
	A#	233	13,980
	B	247	14,820
MIDDLE	C	262	15,720
	C#	277	16,620
	D	294	17,640
	D#	311	18,660
	E	330	19,800
	F	349	20,940
	F#	370	22,200
	G	392	23,520
	G#	415	24,900
	A	440	26,400
	A#	466	27,960
	B	494	29,640
	C	523	31,380
	C#	554	33,240
	D	587	35,220
	D#	622	37,320
	E	659	39,540
	F	698	41,880
	F#	740	44,400
	G	784	47,040
	G#	831	49,860
	A	880	52,800
	A#	932	55,920
	B	988	59,280
	C	1,046	62,760

*Rounded off to the nearest cycle per second.

Tones outside the range of your pitch pipe are easily compared by recognizing the octave interval. The ranges of various pitch pipes are not standardized.

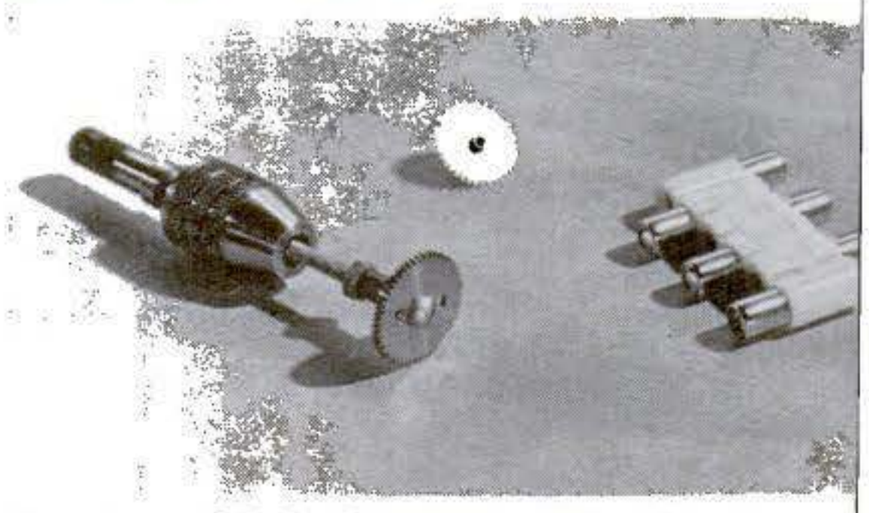
By PAUL E. FIECHTER and R. J. De CRISTOFORO

In 1681, mathematician Robert Hooke determined the relationship between frequency and pitch. He did this by placing a card against a turning, toothed wheel. The action of the spinning teeth against the card created a sound wave—a specific note on the musical scale. When the wheel speed was increased the frequency went along with it. Since the number of teeth on the wheel was known and the rpms were controlled, it was possible to come up with a frequency figure for each tone produced.

By working this technique backward, you can employ the same principle to measure the speed of any rotary power tool to an accuracy of three percent. In your shop you are, really, surounded by notes of the musical scale. If you can identify the notes, and if you have a chart that tells you the frequencies for each, you can calculate the rpms.

We provide the chart—you identify the note. Absolute pitch would be a boon, but it's not a necessity. A pitch pipe (used to tune musical instruments) that you can buy in any music store will help you identify notes.

If you play a musical instrument it will probably be tuned to the American standard of A-440, and you can use it in place of the pitch pipe. The "A-440" indicates that the A above middle C equals 440 vibrations per second. The middle C note equals exactly 261.6. In the chart, however, the notes are rounded off to the nearest cycle per second, which is why,



Mount an old clock gear, or even a bottle cap on a machine screw, to check tools with toothless chucks. Hold the cardboard against the teeth on the wheel to get tone.

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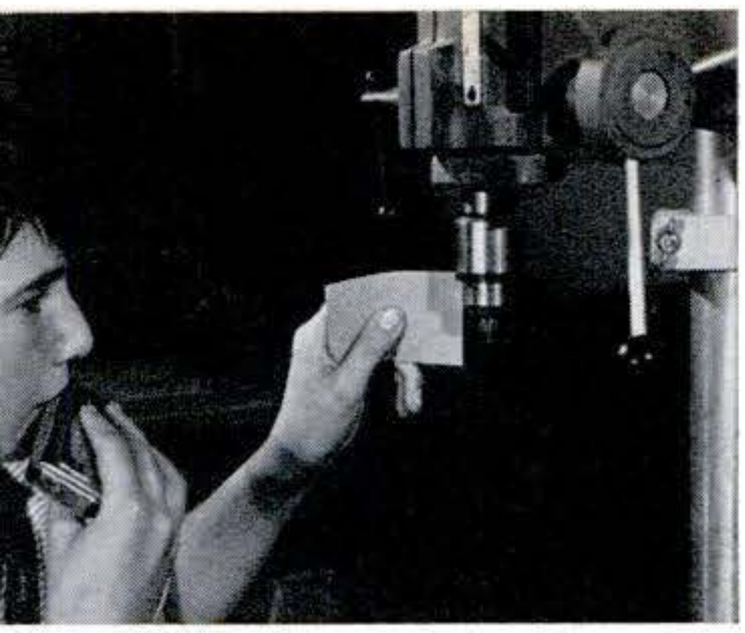
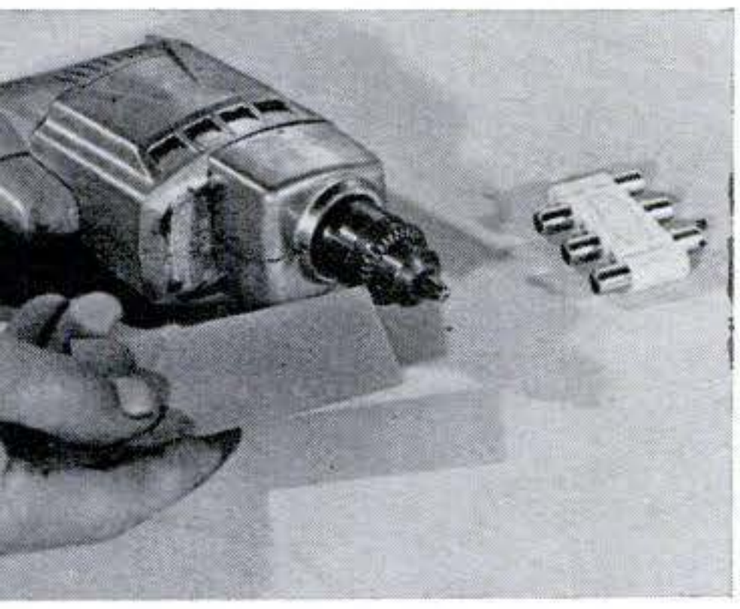


A harmonica and a piece of cardboard can tune you in on the rpms of rotary power tools. Match the singing of the cardboard against the chuck teeth with the same tone on the instrument, then consult chart.



Do the same thing with a portable drill, using an instrument you may already have, or a pitch pipe you can buy. This "stroboscopic" method of checking rpms is accurate to about three percent.

For example, middle C reads off as 262.

To put the idea into practice, let's check the rpms of a portable drill that has a gear-type chuck. Hold one corner of a piece of stiff cardboard or celluloid against the teeth of the tightening ring while the drill is running. The cardboard will produce a tone with a frequency equal to the speed of the drill (in revolutions per second) but multiplied by the number of teeth in the ring. What you must do is match the pitch of this tone to the pitch of the nearest note on the pitch pipe (or musical instrument).

Then use the chart to find the frequency of the note in the "cycles per minute" column and divide this number by the number of teeth on the chuck. The result is the speed of the drill in revolutions per minute.

Pitch pipes vary—this one is used to tune a guitar, but one with a full scale is best for rpm-checking. It gives you more notes to check a broader range.

If you have an SCR-type speed control and an organ or a piano, you can calibrate the speed of your tool against the dial setting on the speed control by successively "tuning" the tool to the notes on the instrument. The calibrations will be in steps of 5.97 percent (six percent for all practical purposes) since each semitone in the scale is that much higher than its next lower neighbor.

Check other tools. To find the speed of a circular saw, mount a combination blade, preferably one with banks of teeth separated by deep gullets. Aim a drinking straw at the gullets and, with the saw running, blow. This will produce a tone and, again, by matching its pitch with the closest tone on the pitch pipe you can use the chart to find the speed of the blade. In this case, divide the frequency in cycles per minute by the number of gullets you are blowing through. This same technique will work with a planer or a shaper.

Naturally, you want to be careful. Set up the straw with the tool still and tape it in place so it can't possibly move when you are blowing through it. Hitting someone with a straw can't do much damage but shreds of one moving at high velocity can. It wouldn't hurt in spots like this to wear safety goggles.

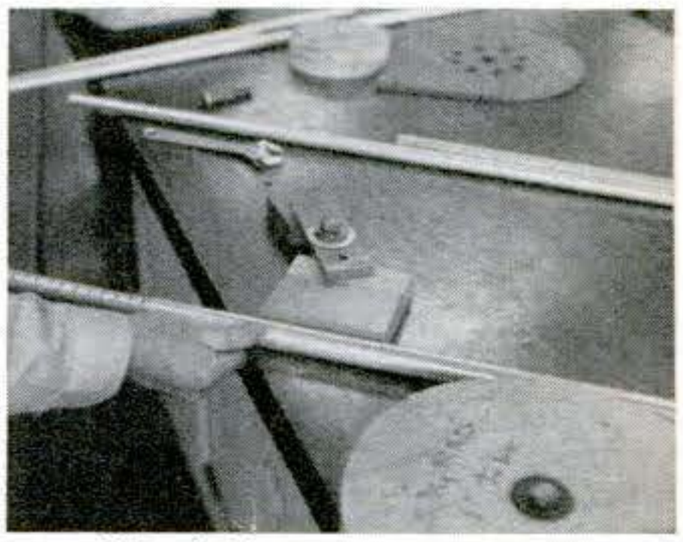
High-speed grinders, and other tools that do not have reduction gears, are readily checked by comparing the tone of the motor itself to the pitch pipe. In situations like this, the "cycles per minute" column is read directly in rpms.

Saber saws and other reciprocating tools are more difficult to calibrate absolutely, but can be checked in terms of a percentage of their maximum speed—again by comparing the pitch of the motor noise to a similar tone on the pitch pipe.

Watch those overtones. Because neither pitch pipes nor power tools generate pure tones at one frequency, but have many overtones, it will sometimes be difficult to avoid a confusion in octaves (an octave has a frequency ratio of 2:1). This can lead to errors when calculating speeds, but the error is so gross that you can't possibly accept it. They can occur in exact ratios of two to one, four to one, eight to one, and so on. Your own experience will tell you that a tool that sounds about right isn't running at one-half or at twice its rated speed.

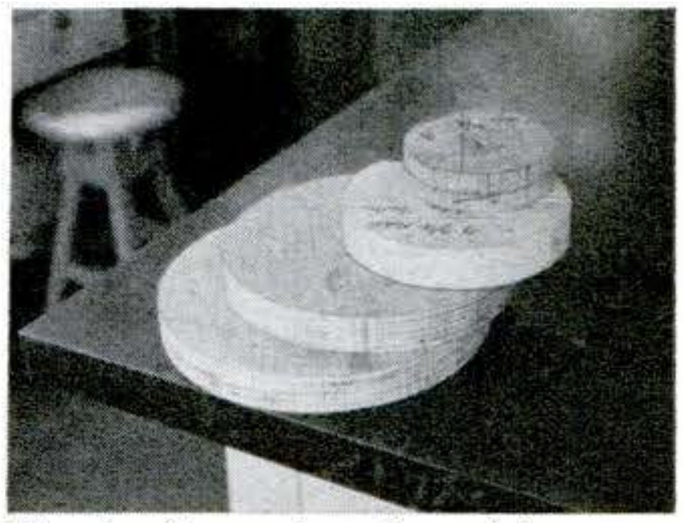
You can have some pure fun with this kind of thing by running experiments. For example, calculate the gear ratio of an electric drill by first measuring the speed of the chuck and then the speed of the motor.

Slick Way to Put a Curve In Tubing

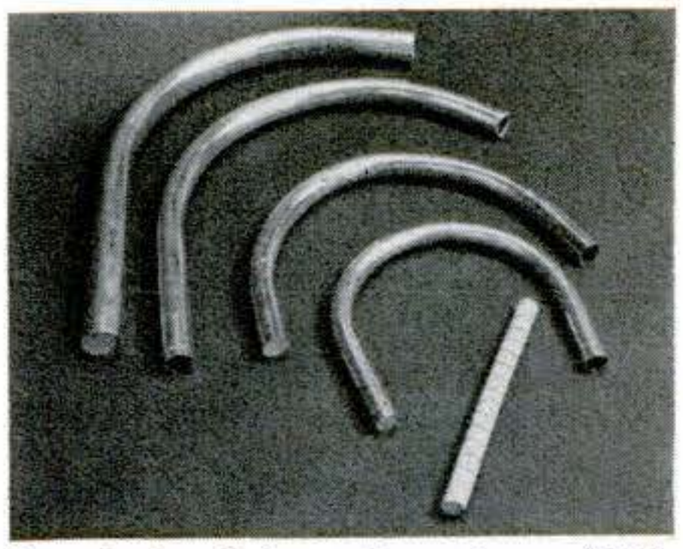


Dowel kerfed 3/4 of the way through at half-inch intervals is secret to bending tube with no kinks. Slip dowel into tube with kerfs on outside of curve.

Bend the tubing around circular forms of 1"-thick wood. Cut these circles to the same radius as that desired in the bends you want to make.



Wooden forms show the minimum-radius bends possible in various tube diameters. Minimums are: 3" for 3/4" tube, 4 1/2" for 7/8", and 5 3/4" for 1".



Sample bends in various sizes of tubing show no kinking. Kerfed dowels inside the tubes must fit snugly. Once tubing is bent, dowels must stay in.

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Could You Bend Up a Chair

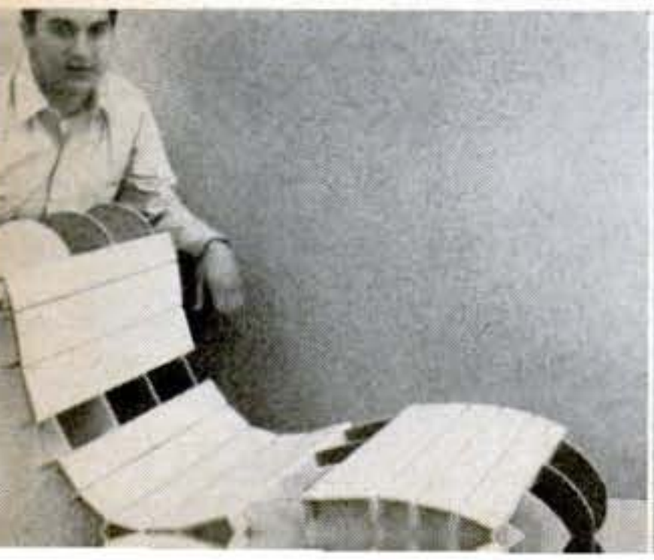
PHOTO BY ORLANDO GUERRA

ELI NIVIN (CENTER CHAIR)

Winning chairs show variety of solutions to same design problem

Cluster of best chairs from two years' judging is shown above with top-rated designer Eli Nivin. Chairs in circle (plus two more) are seen below with their designers. Barrel chair (No. 10) is by Alix Multidor, not shown. All are CCNY students.

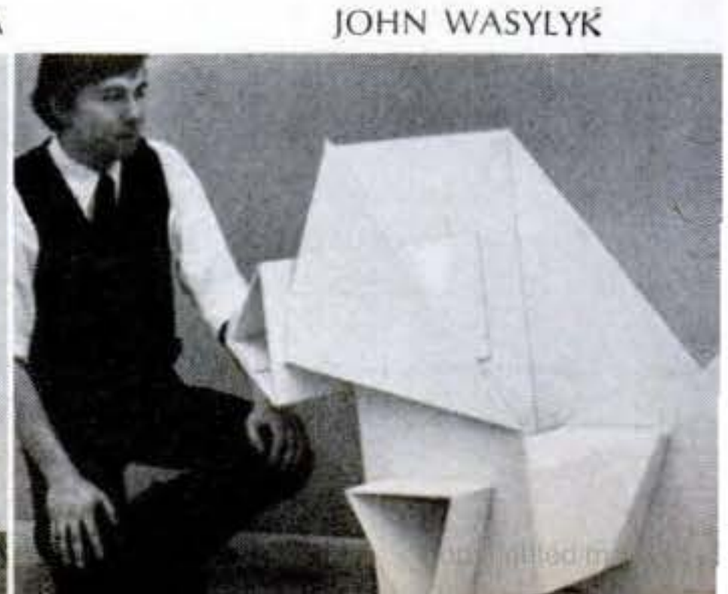
EDWARD GEMMOLA



MARCY KAPLAN

JOSEPH COPPOLA

JOHN WASYLYK



from Foamboard?

That's the challenge presented to these design students—and no glue or fasteners are allowed. Turn page for set of plans to get you started

By **LESTER WALKER,** *Architect*

Unlikely construction materials—such as flimsy panels of art board—tend to inspire ingenious solutions to practical design problems. Sometimes those solutions can be translated into permanent, useful forms. That's a valuable lesson for anyone who tackles do-it-yourself projects.

In addition to my own architectural practice, I'm an instructor at the CCNY architecture school. I've found that the most effective way to teach architecture to beginning students is to assign simple but practical problems relating to human shape. The most compact "living machine" is a piece of furniture—and what could pose more basic questions of form and function than a chair? Common sense about structure, strict adherence to human dimensions, and a good, sound design attitude must all be employed in creating a successful chair.

With no fasteners. For a couple of years, now, I've assigned my second-term students a three-week exercise consisting of the development of a full-size chair from a maximum of two ¼″-thick 40″-by-60″ sheets of foamboard—using no fasteners or adhesive material such as glue or tape. (If the design permits, the student can substitute four 30″-by-40″ sheets of the same material.) On a specified target date, the resulting chairs are lined up for rating—and testing—by the entire school. After three hours of enthusiastic "musical chairs," only the best-designed chairs are left standing. A selection of "survivors" from two judging sessions is shown on these pages. Some of these chairs have actually been used for over a year. POPULAR SCIENCE also asked my top-rated student designer to prepare finished cutting plans for his chair, and to reproduce it, step-by-step, for their photographer. This sample project will teach you the principles of working with foamboard, and may challenge you to create your own design.

The panel we use. Our material is a brand of graphic-arts board—Fome-Cor—that is a lightweight sandwich laminate of polystyrene foam between white Kraft-paper facings. It's used for display cards and can be purchased at major art-supply houses for around $3 a 40″-by-60″ sheet. If you can't find it locally, write the manufacturer (Monsanto, No. Seventh St. and Monroe Ave., Kenilworth, N. J. 07033) for your nearest source. You could even experiment with something as common as corrugated board.

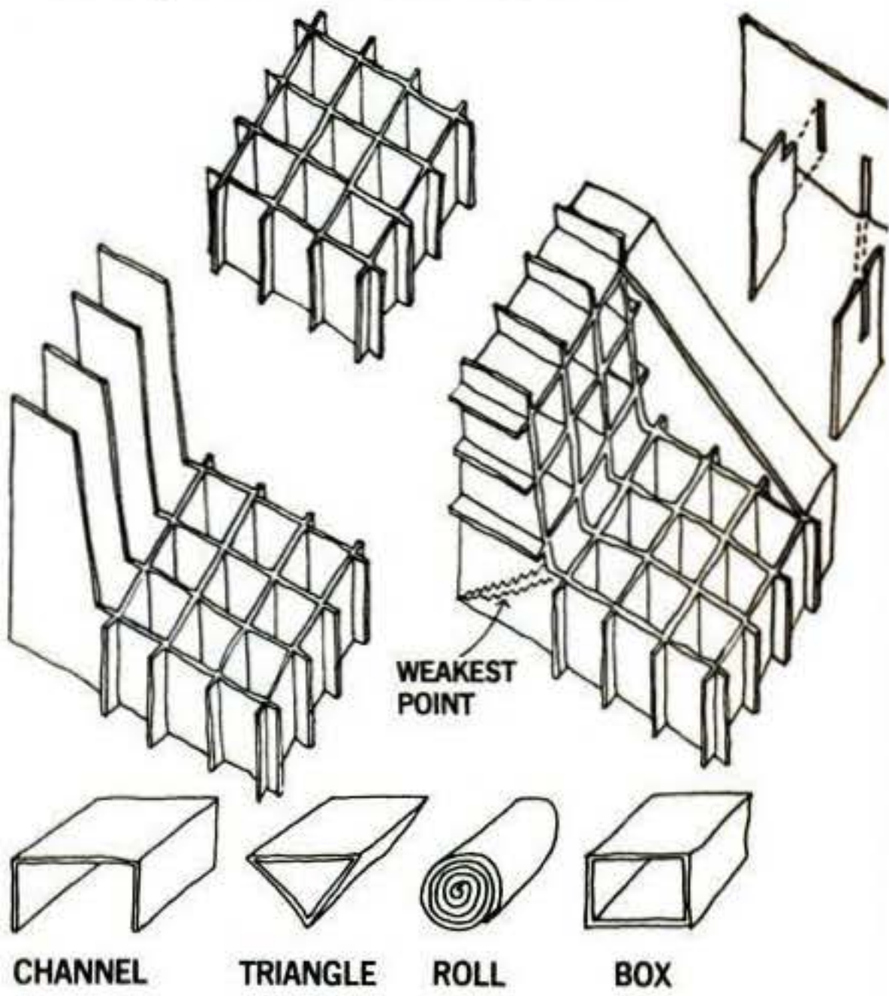
The point of the exercise is to compress all of the phases of the architectural design process into three weeks. Students learn the value of sound construction techniques by seeing their finished product subjected to three hours of actual use.

There are many interesting parallels between the processes of designing a chair or a building. A primary consideration in architecture is economy, as expressed in the efficient use of materials and the necessity of multi-functional parts. In chair design, this may be represented by an armrest that also structually supports the back, as in my sketched example, right. Actualizing his design concept in a full-size mock-up requires the student to make accurate construction drawings, and presents him with the acid test of any design: Does it work?

Strength from weak stuff. There's even a parallel material used today as wall systems in large buildings—a stressed-skin sandwich panel with metal facings. Working with the foamboard, the student learns the principles of developing strength from a

We introduced Lester Walker in our July issue, with plans for one of his Living Machines—a multipurpose unit he called Turniture. The young architect also teaches at City College of New York (CCNY), where his students design and build chairs which are then lined up for popular judging. Photo above shows this year's session. Three hundred students tried out the chairs, then scored them on comfort and appearance. Best chairs are shown on these pages.

Strength from weakness



Construction principles for designing with weak panel are shown in Walker's sketches. At top: egg-crate grid makes strongest seat; assembly is done by slotting for tabs or half-laps. Back can be attached or extended from grid, as in center sketches; to support weak point, armrest can double as tension "cable." Bottom: four basic beam shapes.

KENNETH FANELLI

EMIL SOBOLAK

SIMION THIERER

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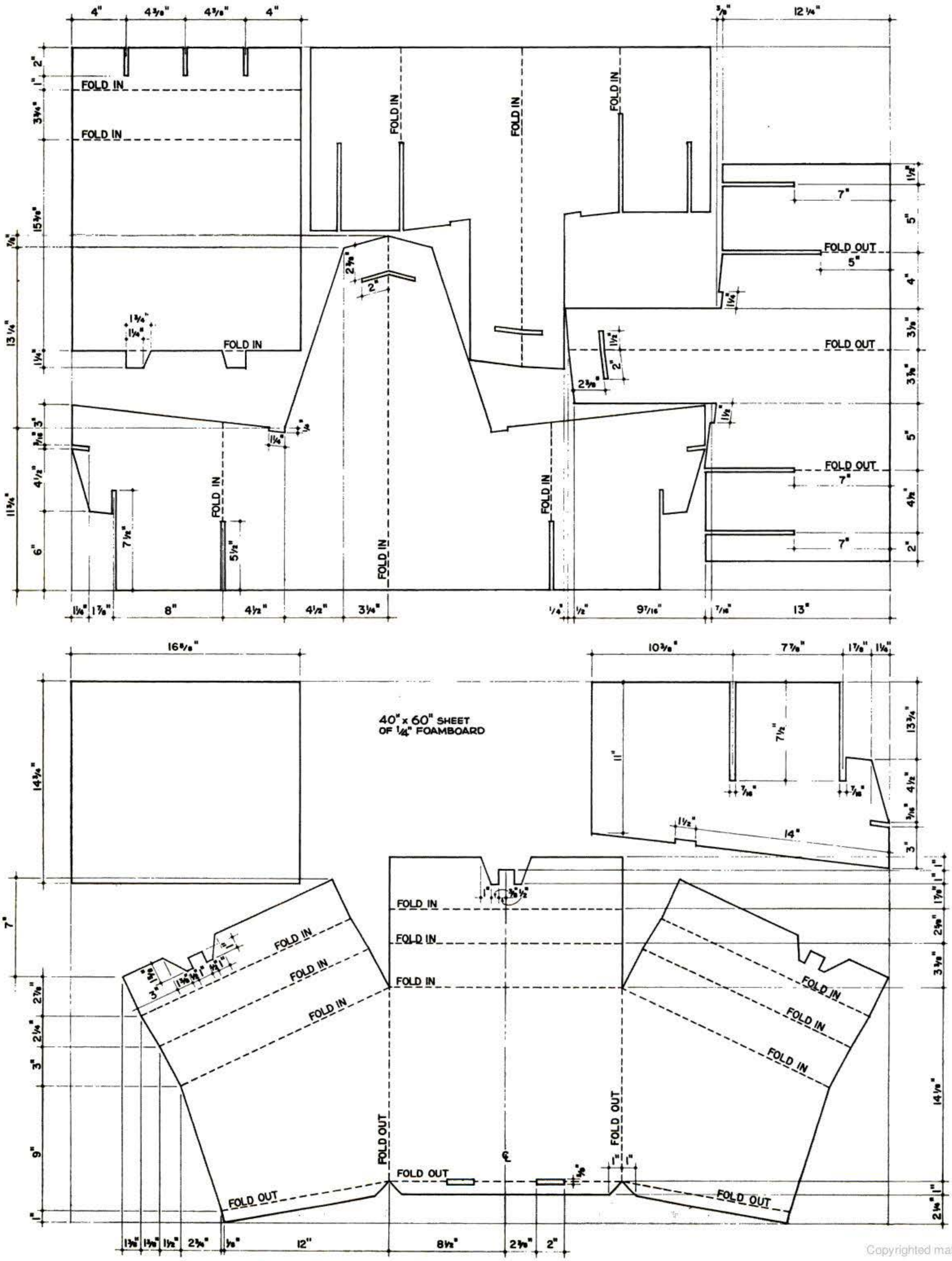
relatively weak panel. And he can develop his project on a true human scale, impossible with a proposed design for a building.

Even so, it's best to start—as my students do—with a scale model in cardboard. Even if you merely clip the patterns from the page below, you will find they'll fold up into a perfect model of the full-size chair. You'll note such a model of the base unit in the first of the assembly sequence photos on the next page. (The assembly took only two minutes.)

This whole design process has a home workshop application. You can test your furniture ideas by making inexpensive mockups in foamboard that can then be adapted for construction in plywood—or even Plexiglas. Let your imagination loose!



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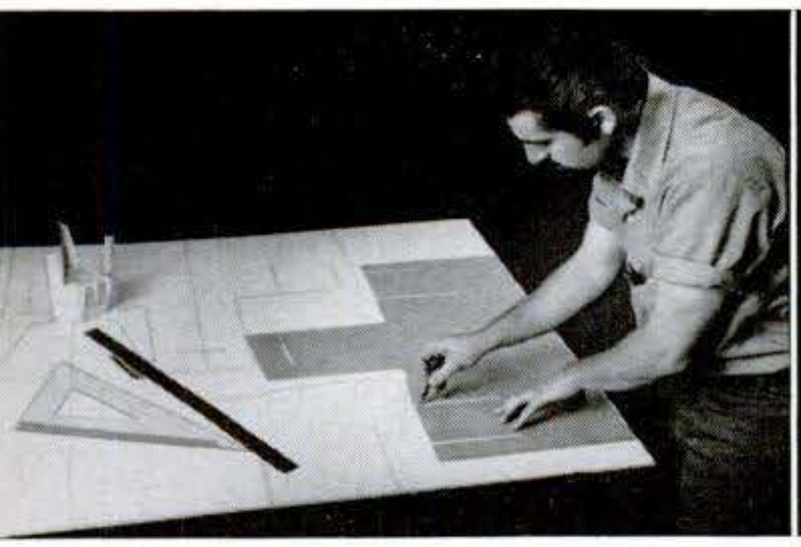
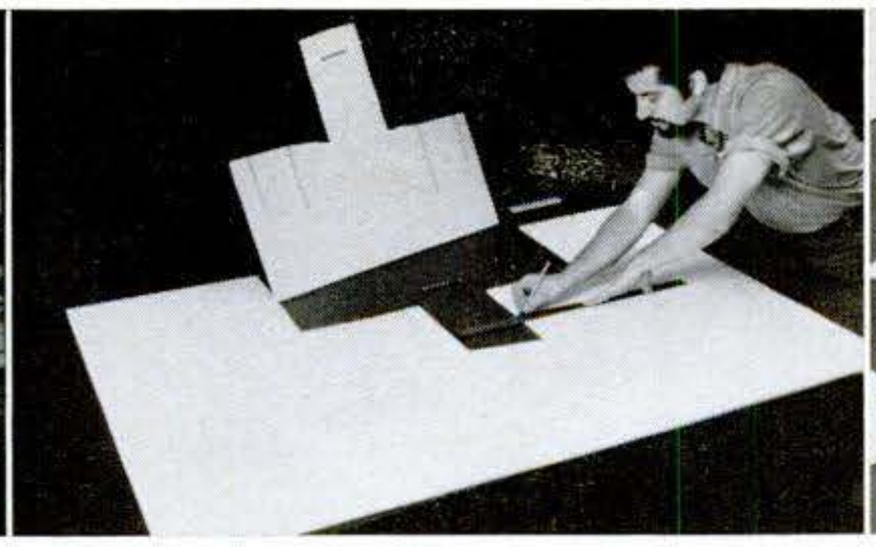
Here's how the designer made his top-rated chair from two sheets

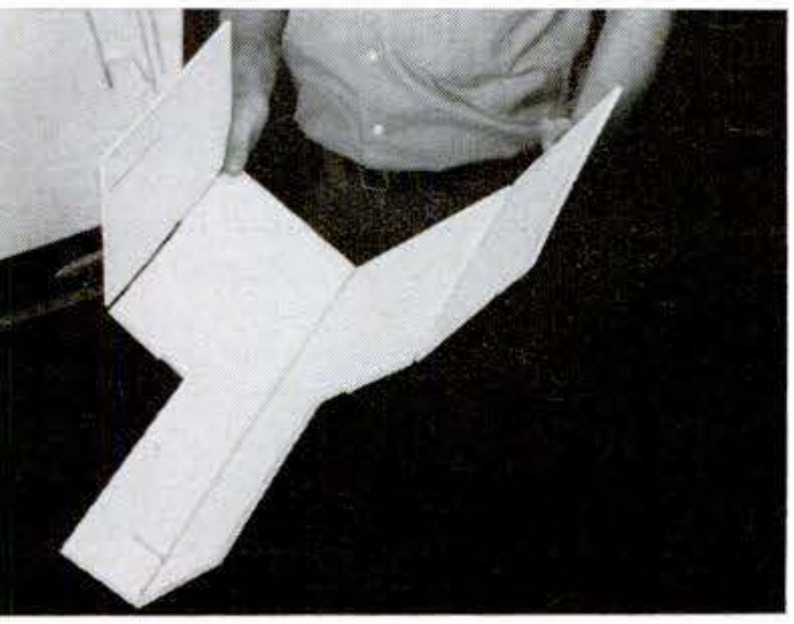


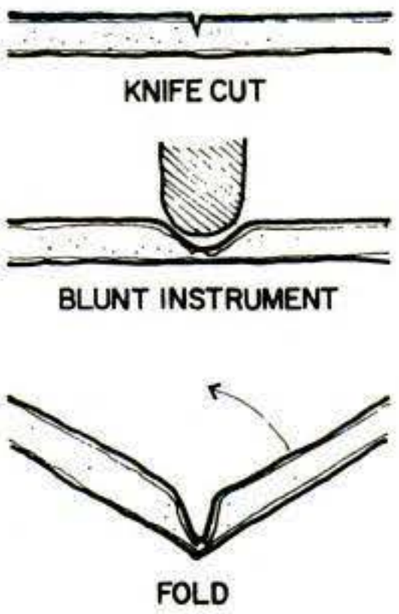


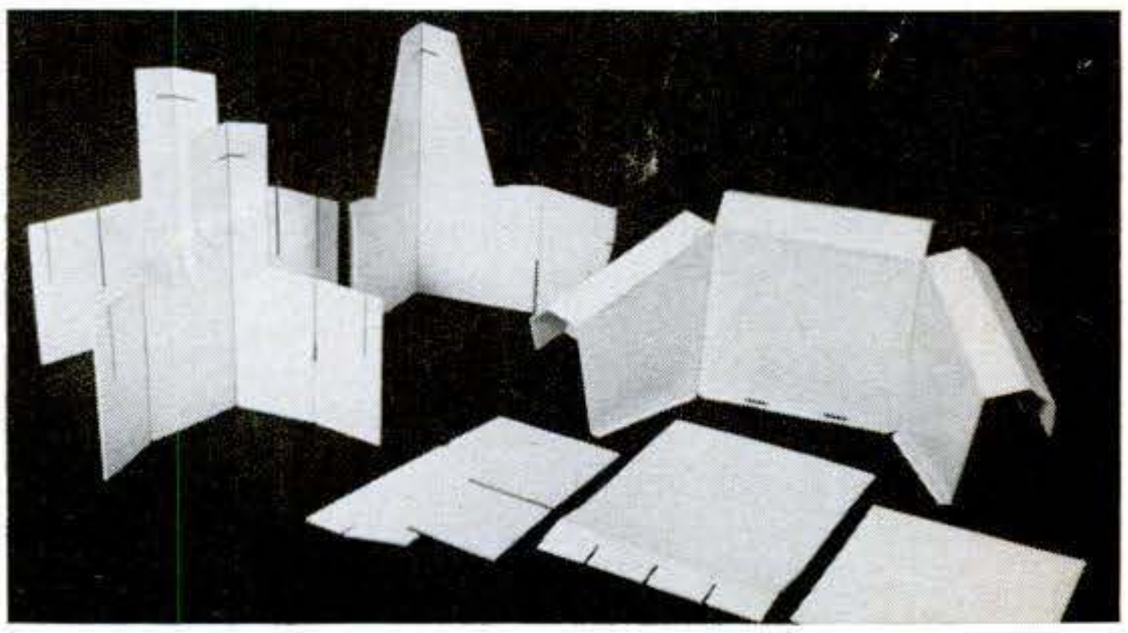
1 Since layout is critical (note tight fit of pieces on 40"-by-60" sheets on the facing page) it's best to make full-size patterns, trace around them on foamboard.

2 Cut pieces out, using razor blade or matt knife with metal straightedge. On inner face of each fold line, make a shallow cut as shown in the knife-cut sketch below.

3 Now score along each fold-cut with a blunt point such as this brush handle. Scoring is always done on the face toward which fold will be made (see plan).

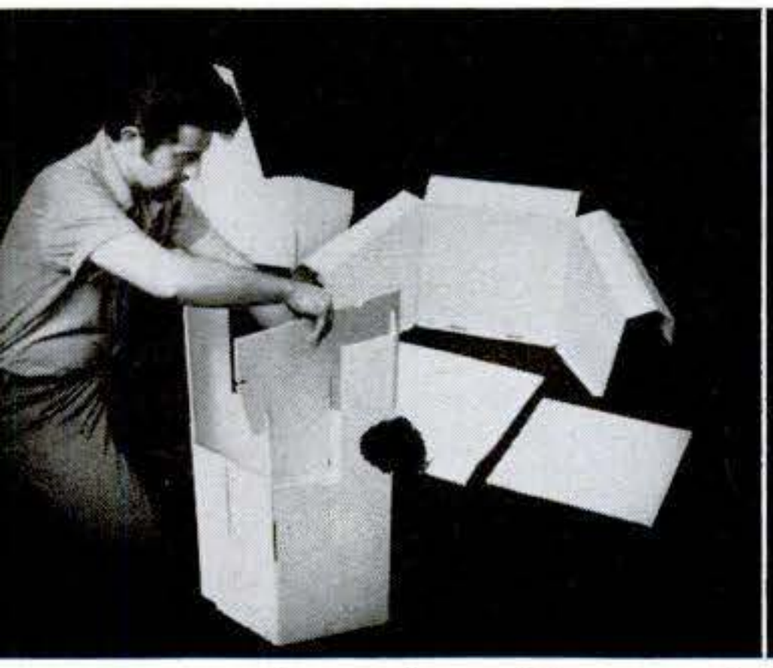


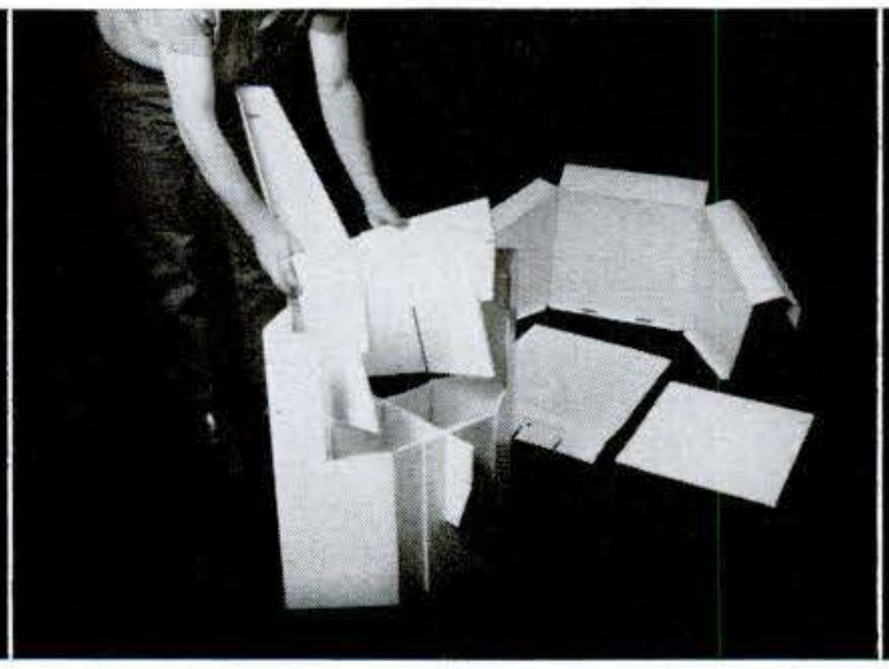


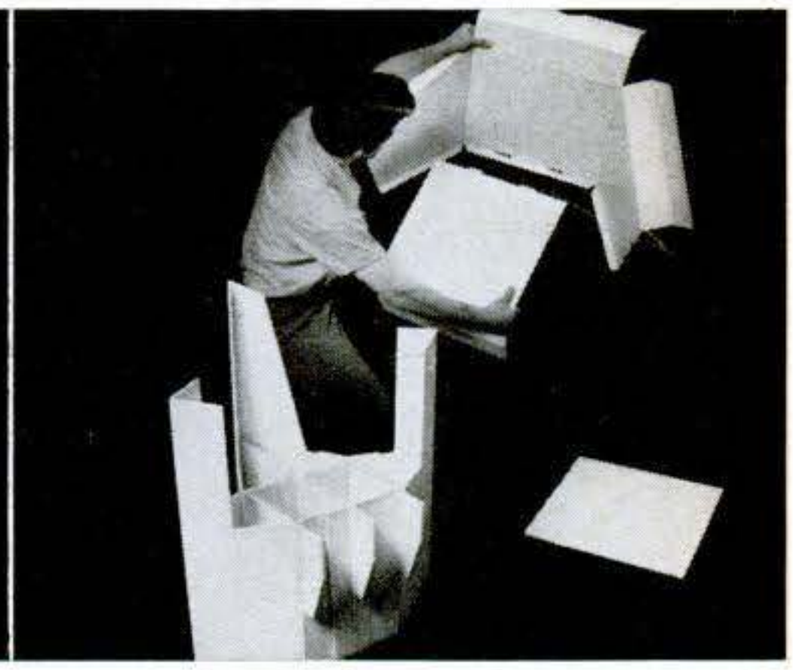


4 Make all folds. Shallow cuts have slit the inner face, scoring has compressed core to ease folding. Practice will show how deep to score for various angles, retaining maximum strength.

5 Here are all pieces ready for assembly: base-support members at left, bucket-seat parts at right. Plans on facing page show how little of the material is wasted (gray areas).



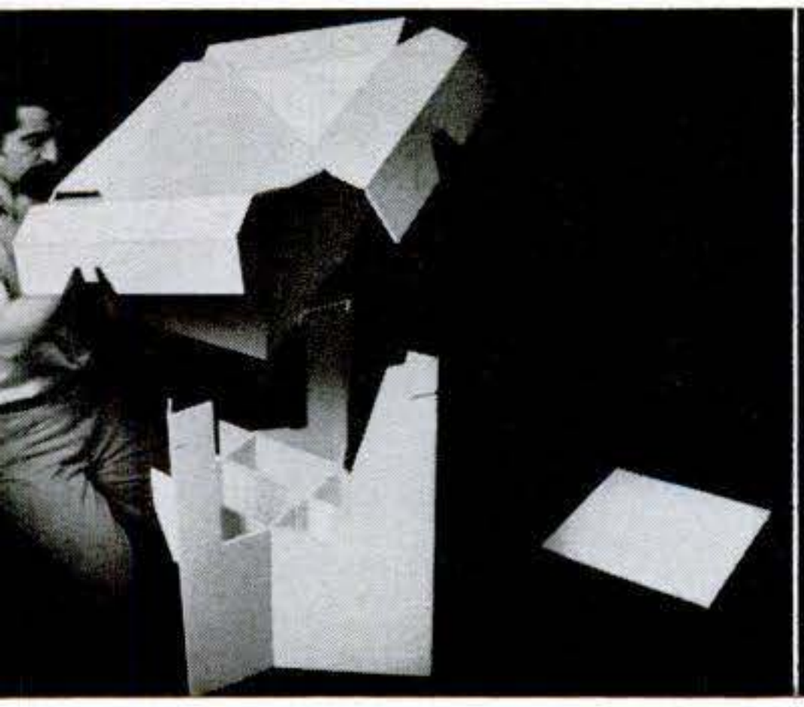


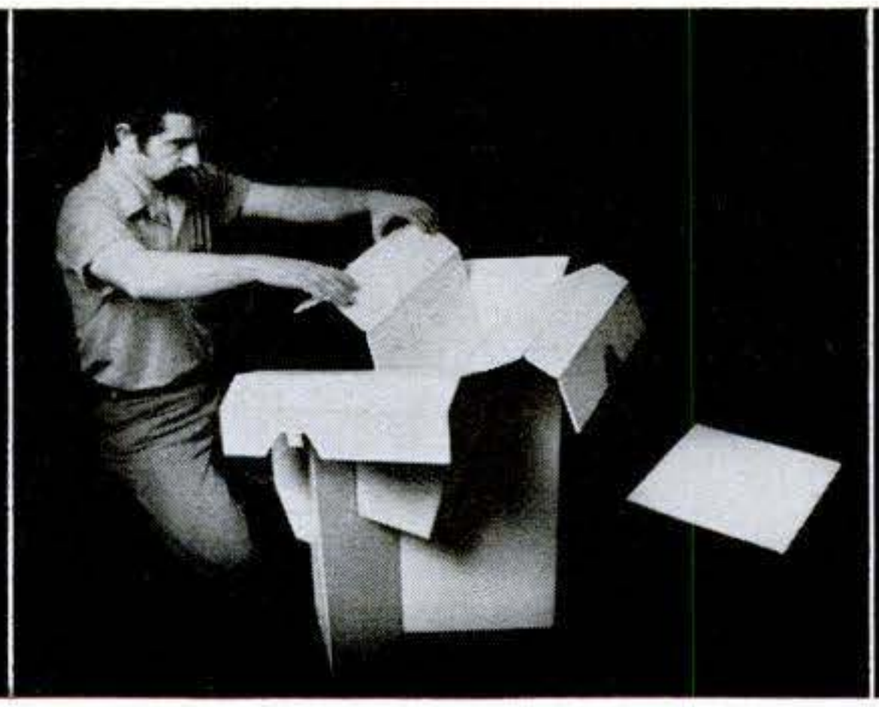


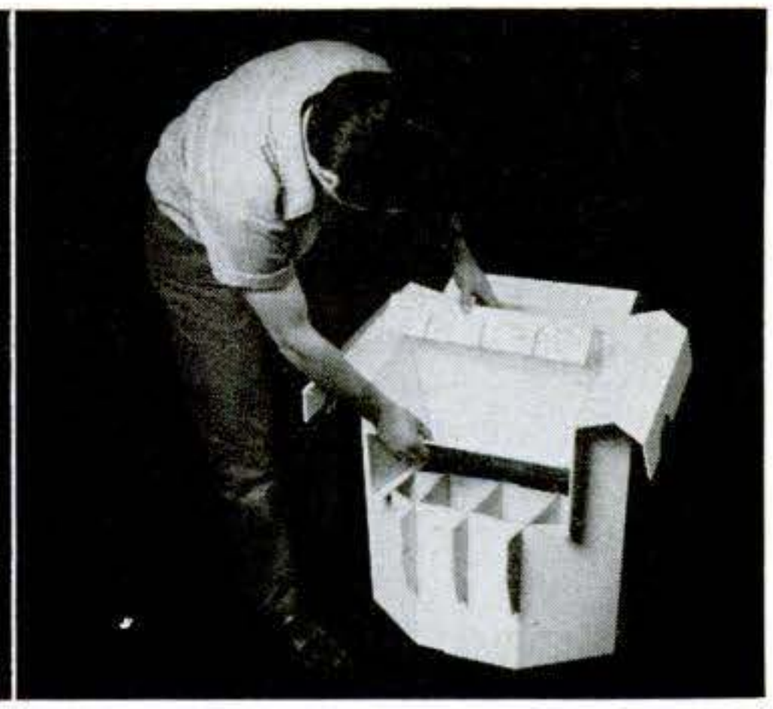
6 Set two side members of base together, overlapping and aligning slots. Lock together with center piece, inserted as shown —first step in forming egg-crate grid.

7 Add back by notching it into base slots. Except where indicated, slots should be tight—about 3/16" wide for a good fit. This completes the egg-crate seat support.

8 Assemble the bucket by inserting tabs on seat member into slots at base of back. To lock tabs in place, flatten and fold down; this is critical tension joint.







9 Drop bucket into base assembly. Tripod extensions support bucket flaps that fold into back and arm box-beams (see photo of the completed chair on previous page).

10 Check assembly of bucket to base by folding box-beams; tabs must match slots. This design proves that the more a panel is folded, the stronger it becomes.

11 Reinforce seat by slipping extra loose panel in atop egg-crate grid before anchoring lip of seat. This lessens dimpling. Insert remaining tabs in slot. PS

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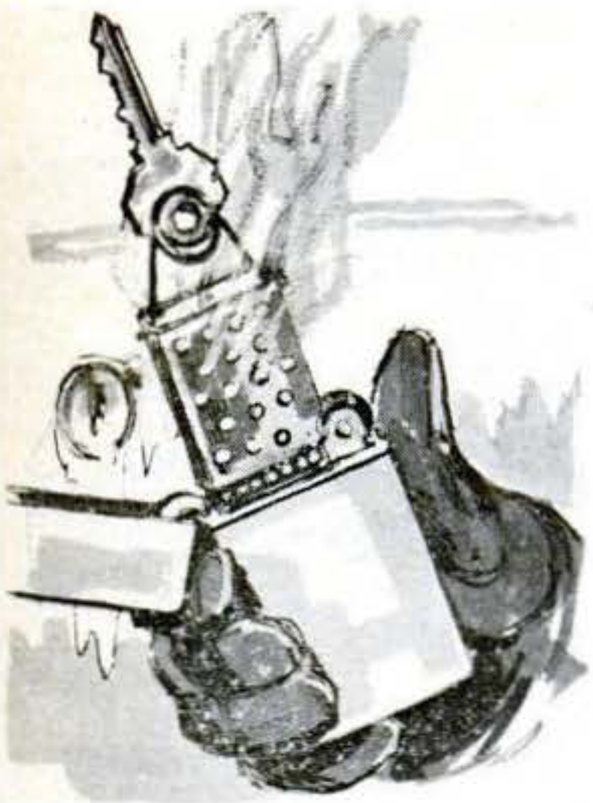
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY DANA RASMUSSEN

Scrubber mounts on car. You'd use less water to wash a car in less time with this recently patented garden-hose attachment. Adjustable wrap-around tubing lengths would spray a car's top and sides at the same time. With a hose fitting, the washer could apply wax or detergent along with the spray of water.

Pot handle checks temperature. Heat from the bottom of this pot would travel along the looped-metal handle. Heat-sensitive elements spaced inside the handle would warm up in turn so you could tell by touch (starting at the far end) when the pan's contents had reached the desired temperature.

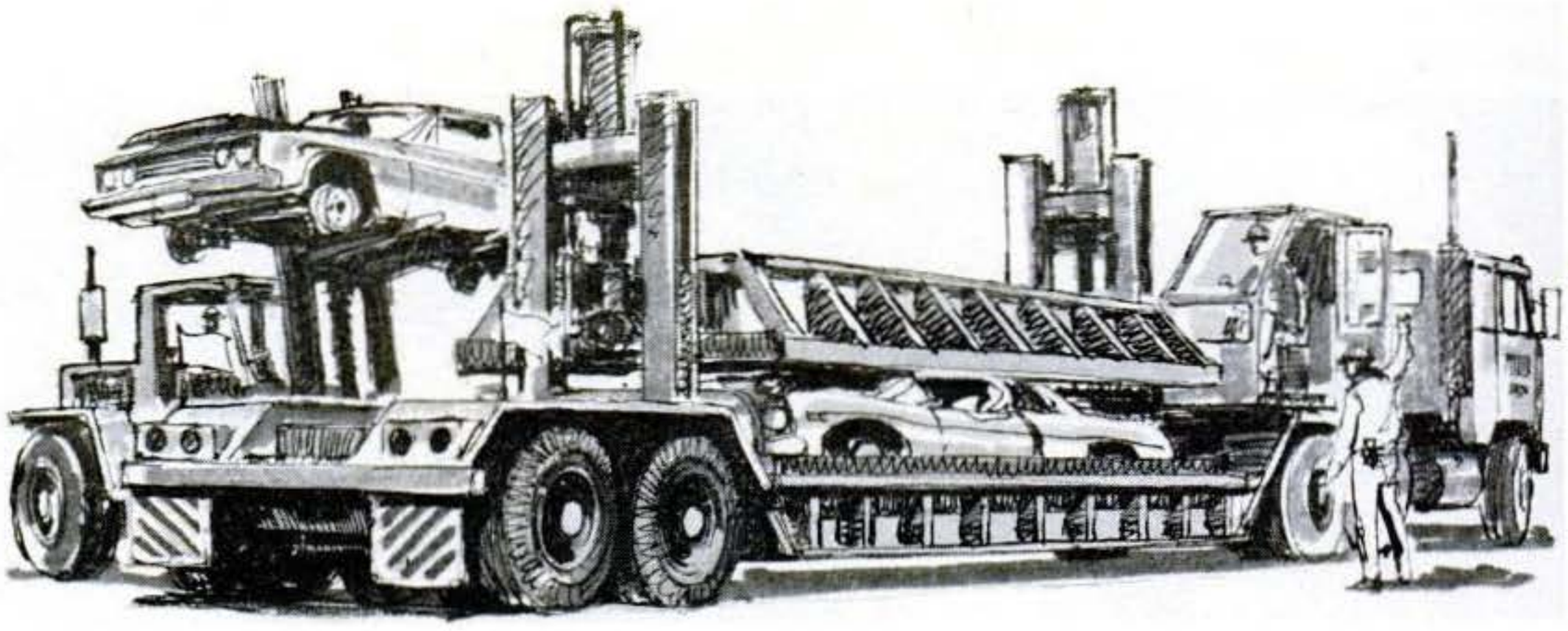
Motor screw tows skier. Powered by a small gasoline engine, a pair of spiral-ribbed cylinders in this novel tow would pull a skier cross-country and even up grades. The shallow, widely-spaced ribs would provide traction in light or deep snow, without clogging or digging in too deeply.



Chimney warms key. You could quickly thaw an ice-jammed lock with this slip-on attachment for a cigarette lighter. The key-gripping chimney would expose a key to heat and the lighter would provide the handle for manipulating it in the lock. Heat could be maintained until the frozen tumblers were de-iced. The chimney would not interfere with normal key usage.

Cleat flutes lock rope. Wavy ridges inside this V-slotted hawser cleat would grip any size rope or line much the way a nut grips the threads of a screw. By eliminating the normal friction grip (which is concentrated at points along the rope) the cleat is said to produce a tighter hold—especially on smooth synthetic fibers—with less wear and deformation of the rope.

Mobile press compacts debris. Abandoned cars and other bulky trash could be cleared and collected much more easily if they were squeezed down on the spot into space-saving, easier-to-handle bundles. This truck-mounted press could crush one scrapped car between its base and a hydraulically powered head, then easily take a second car on top of the first and press the two into a single compact mass ready for the scrap yard.



The following patents have been issued on these inventions: **Car washer**—*No. 3,401,707 to M. Horwitz, Winnetka, Ill.;* **Pot watcher**—*No. 3,405,678 to R. and H. Frenkel, N.Y., N.Y.;* **Ski tow**—*No. 3,405,777 to M. von Kemenczky, Point Pleasant, N. J.;* **Lock de-icer**—*No. 3,023,748 to E. Bruskin, Malverne, N. Y.;* **Hawser cleat**—*No. 3,398,714 to C. Wallin, Bergliden, and K. Kock, Saltsjo-Duvnas, Sweden;* **Mobile press**—*No. 3,404,622 to R. Flanagan, Dallas.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, address him (by name and patent number) in care of the Commissioner of Patents

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The Sea-Horse 60. The only way to get fishing any faster is to fly in. Once there, the 60 will troll smoothly and quietly. As a single, it cuts an inland lake down to arm's length. Paired up, it brings offshore fishing in range. No matter what you're angling for, the new 60 is a keeper.

New "pressure-back" piston rings*, first ever in a production outboard, help develop the kind of thrust and speed to stand up a slalom skier in deep water and then stand up the hair on the back of his neck.

Racers love to give this 60 its head — and what a head: 3 cylinders, 3 carbs and Power/Pulse solid state ignition in a Loop-Charged engine. What's Loop-Charging? It's fuel compression and exhaust ejection in one continuous loop through specially aimed cylinder ports. Gone are deflector-topped pistons and chambered heads of standard 2-cycle power. The new 60 sports lighter pistons and heavier trophies.

The new 60, like every Sea-Horse from 115 to 1½ hp, is covered by this exclusive two-year warranty: For 24 months after purchase, Johnson Motors will replace or repair without cost to the original purchaser any part of its manufacture, which, upon inspection, proves to have failed in normal pleasure use due to faulty material or workmanship.

There are prettier shapes underwater, but they all wear bikinis. This lower unit is hydro-dynamically clean to minimize turbulence and drag. It tapers to a slim new one-piece gearcase.

Underwater treasure includes your choice of seven custom-matched props as standard equipment. Or, you can get fitted out with any of three more high performance optional bronze props.

You start it with a key and stop it with reluctance. In between, Johnson's exclusive Hydro-Electric power shift makes changing direction as easy as changing your mind. Shift and throttle are combined in a single lever. Smooth. And a friction brake holds it wherever you set it. Great for cruising.

FIRST IN DEPENDABILITY

Johnson Div. Outboard Marine Corporation

is the way to go!

See this Sea-Horse 60 at your Johnson dealer or write for a free catalog. Johnson Motors, Waukegan, Illinois 60085, Dept. PS-72.

*Patent Applied For

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A Modern Bowl for Sun-Bathing

Make it from three fir plywood panels and paper-backed aluminum foil. Turn the bowl upside down—presto! You have a playhouse.

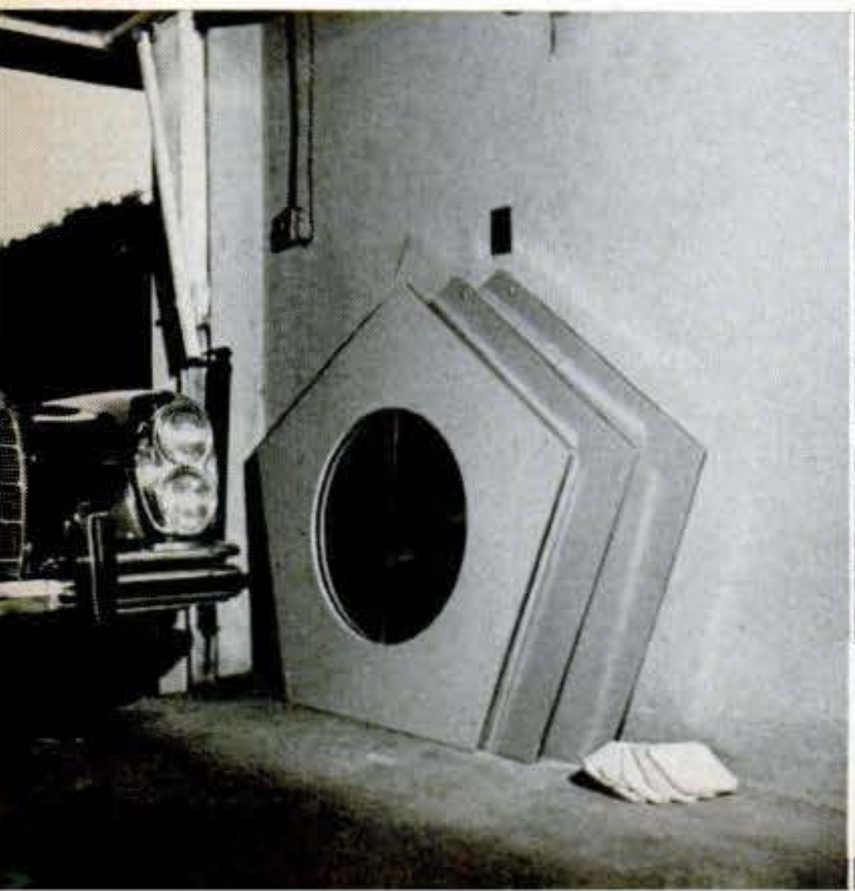
By KENNETH ISAACS
PS Design Consultant

One of my major design objectives is simplification of our man-constructed environment. Techniques I've developed to accomplish this include application of long-neglected geometric forms. Such forms offer economy of structure, physical strength, and the beauty of simplicity. An example is the dodecahedron, a solid composed of twelve faces, each a regular pentagon. This figure was described by the Greek philosopher, Plato, in the 4th century B.C. Even earlier, the Pythagoreans had called the figure the "atomic building block of the universe."

While working with models of this form a few years ago, I discovered that one-half the volume would make a fine reflective suntrap for winter use. This structure is physically strong and easy to make. You make it of plywood, line the interior with aluminum foil. The joints allow quick knockdown and compact storage.

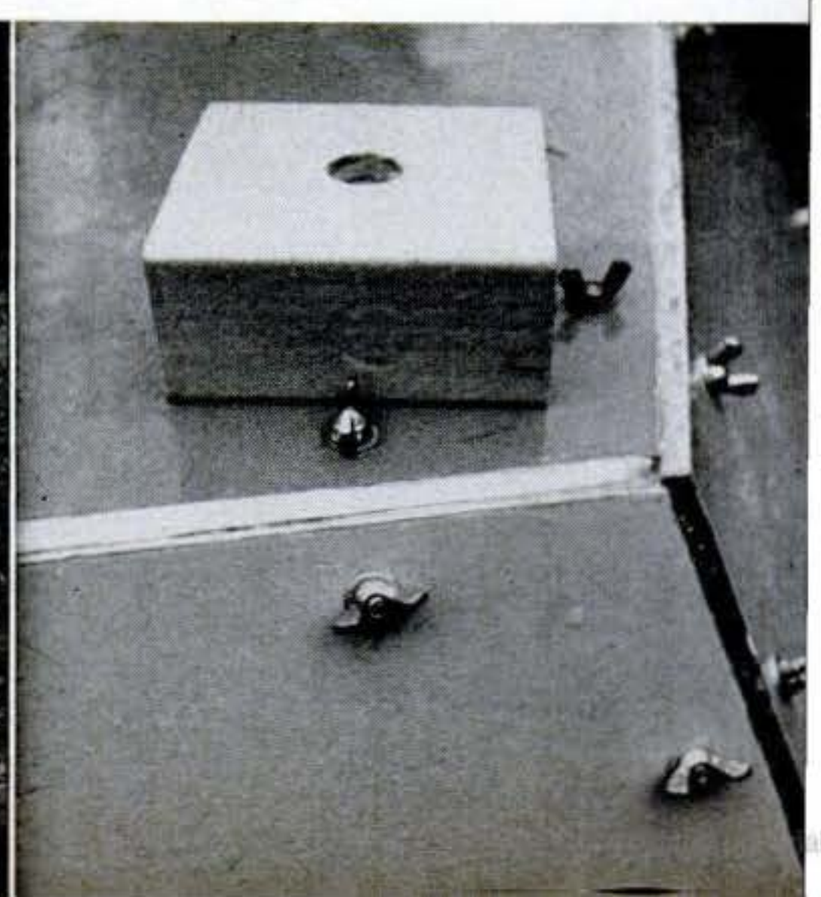
Inside the bowl you can enjoy health benefits of the sun throughout the year. Its walls shield you both from winds and prying eyes. In cold weather you may prefer to bundle up and recline on cushions to reduce heat

You'll encounter no storage problem with the bowl. The pentagons come apart easily and store flat, as you see in this photo.



To assemble bowl, you place the bottom pentagon flat and prop one side pentagon in position while you attach fasteners.

Wingnuts are used for easy assembly of the bowl, as you see in this closeup of a bottom corner. Also note the foot block.



KENNETH ISAACS, PS Design Consultant . . . holds an MA degree from Michigan's Cranbrook Academy of Art, where he later headed the design department. He has been a visiting lecturer at the Illinois Institute of Technology and the Rhode Island School of Design.

His professional credits include a grant from the Graham Foundation for Advanced Research to further development of his Micro-houses. In addition, the Council of Industrial Design in London named Isaacs and dome-builder Buckminster Fuller the outstanding personalities in design education in the United States.

transfer through the plywood walls. You should increase your tan whatever the month.

A playhouse, too. Turn it upside down with the points resting on special blocks and the bowl becomes an appealing playhouse for the youngsters. That position also keeps out rain. Users crawl in through the same 24″ diameter hole, whatever the position.

When you buy materials, see if the lumber yard will cut the 4′-by-8′ panels into 4′ squares. Handling will then be eased all along the line. Choose only plated hardware. You'll find suitable paper-backed aluminum foil at stationers or wallpaper stores. Buy a quart of cement at the same place.

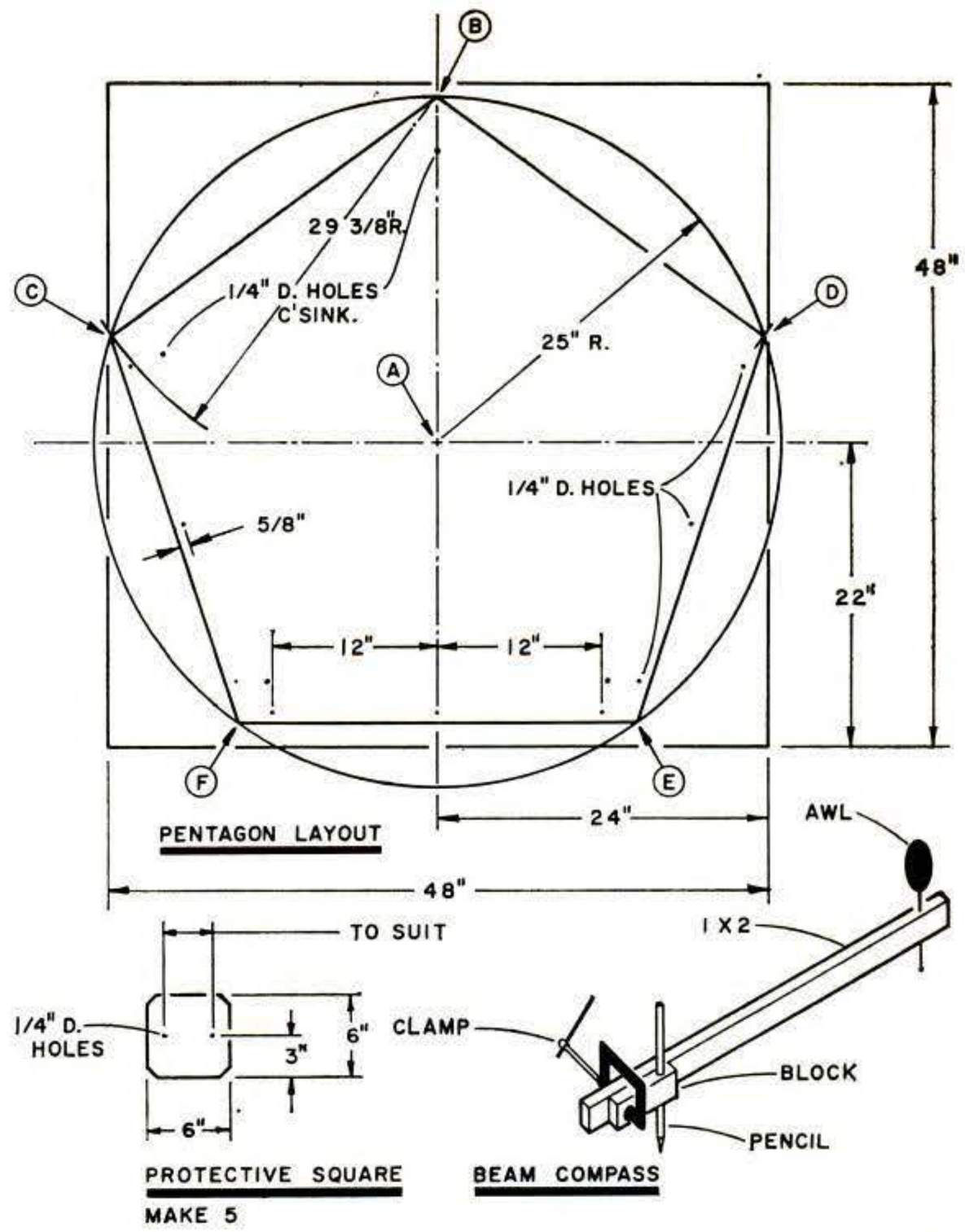
After laying out the first pentagon, cut along the lines with a fine-tooth saw, being careful to splinter the wood as little as possible. True the edges with a fine wood rasp and finish with fine sandpaper on a block. Hold both the rasp and the block at 90 degrees to the face.

Use the master pentagon to mark out the others. Lay it on the plywood blanks, clamp in two places, and mark just the corners. Use a good straightedge and connect the corner marks. This insures more accuracy than marking around the pattern.

Use the compass to draw a 24″ circle for the access hole in one of the pentagons. The center of the figure is located by drawing a straight line from any corner to the center of the side opposite. Do this for all the corners and the resulting intersection will be the center of the circle. Instead of leaving the hole open, some people may prefer to save the cutout disk and hinge it into the hole at the top. That way you increase privacy and cut down on breezes as you sunbathe.

Drilling. Sandwich the six pentagons with the master on top and clamp all around. Lay out the three holes in each edge. For accuracy, drill with an electric drill held in a small drill stand. Holes are ¼″ diameter. Their distance from the edge must mate with the corner irons. Note that these should be the type called inside irons.

[Continued on page 130]

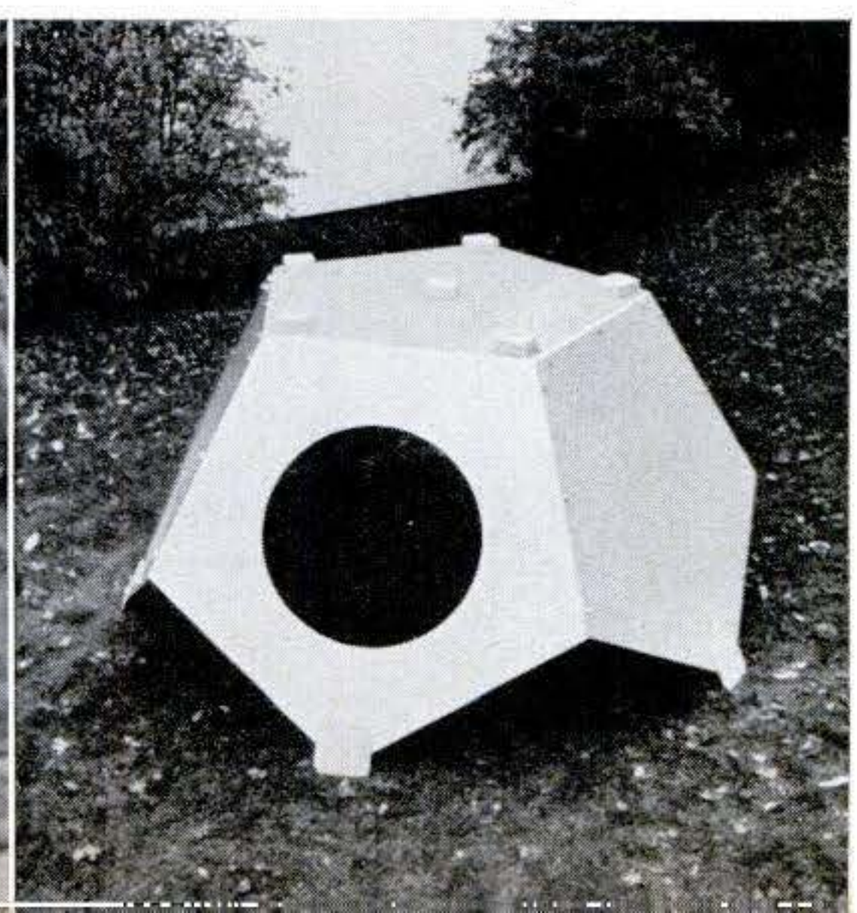


How to lay out the pentagons. Cut each of the 4′-by-8′ plywood panels into 4′ squares. Then prepare your layout very carefully; all edges must be equal if the bowl is to assemble nicely. A beam compass made as shown will help. Drill a tight-fit hole through the one-by-two for an awl. Drill another tight-fit hole in a one-by-two block for a pencil. Clamp this block to the other end of the beam. First mark off vertical and horizontal center lines, placing the horizontal line 22″ up from bottom edge of the panel. Then set the compass for a 25″ radius. Using the centerpoint A, draw as much of the circle as you can. Don't worry about the sections that go off the board. Next, set the compass for 29⅜″ and use B as the centerpoint to strike arcs intersecting original circle at C and D. Using the same setting and C as the center, mark off point F. Repeat with D as a center, and establish point E. As a check, use point E as a center and see if the arcs cross and coincide at point F. Cut the first pentagon and use it as a pattern for laying out the other five. For accuracy, mark the corners and connect these points by using a straightedge.

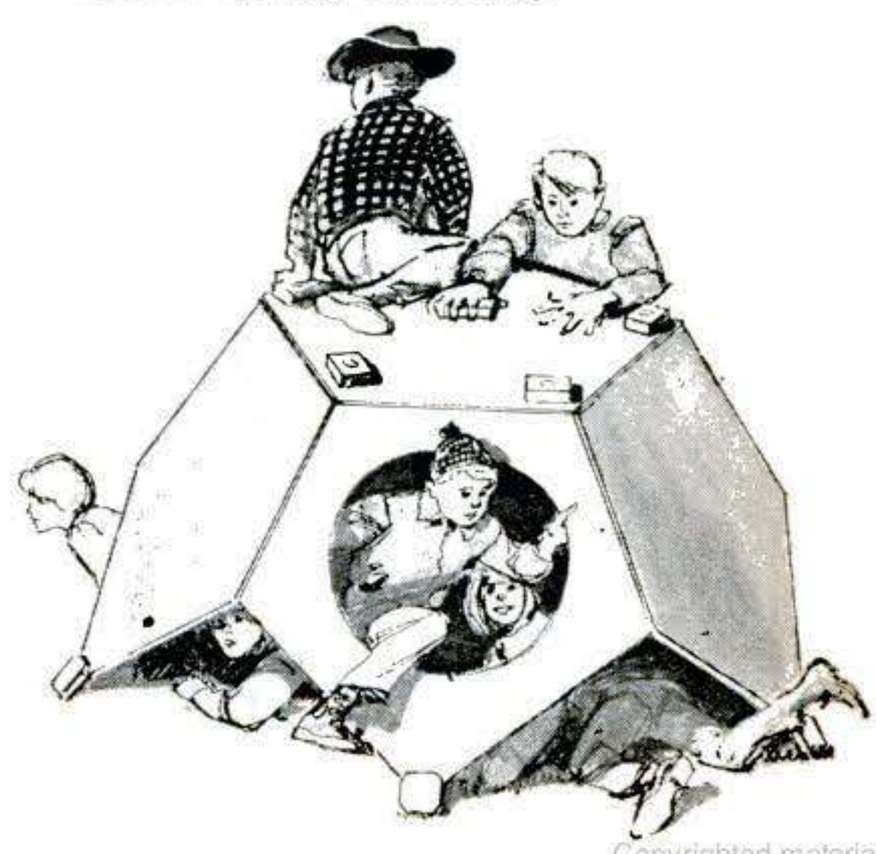
Make the protective squares shown in the drawing above from scraps of ⅜″ plywood. Use these to protect the points when the bowl is turned over. Nip the corners at 45 degrees for safety.

Protective pads are bolted to all of the five points of bowl before it's turned upside down while not in use for sunbathing.

Bowl is light enough so that one person can turn it upside down to keep out rain, snow, or dust after finishing a sunbath.



Bowl is a great playhouse too, in its upside down position—a fact that makes its construction doubly rewarding.



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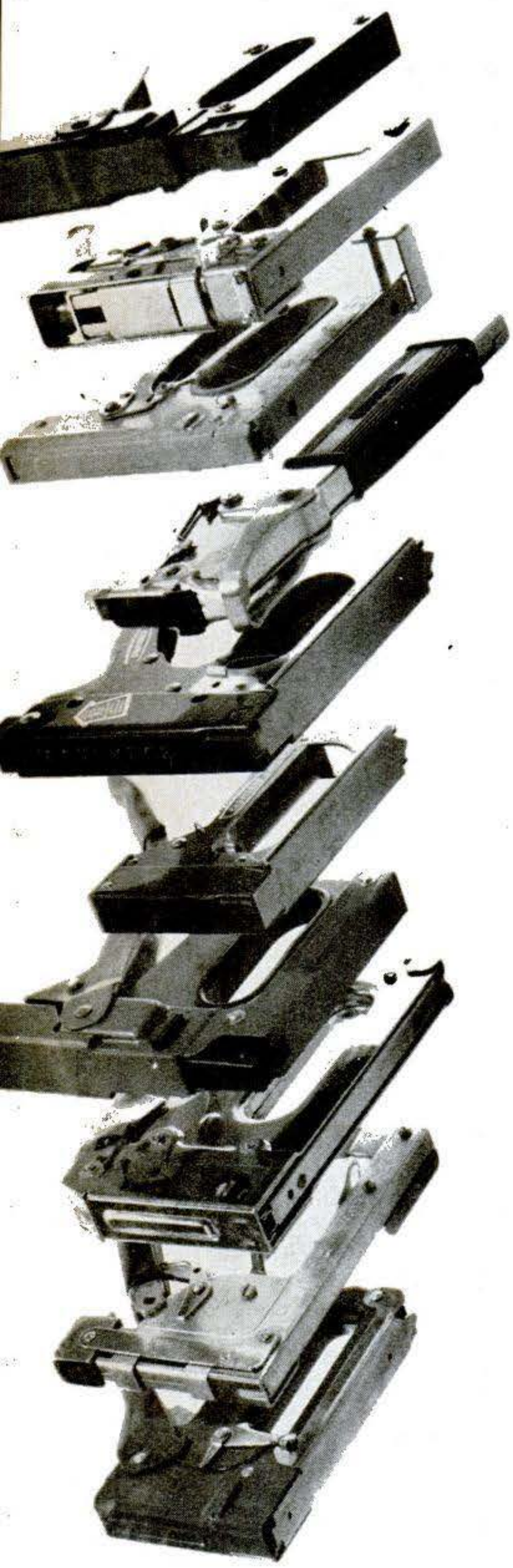
Reach for Your STAPLE GUN

It'll fight more of your battles than you think—once you master a few tips. Don't own one? See our chart



Typical home staplers (from top): Markwell L-3, Duo-Fast CT-859, Swingline 900, Bostitch H2B hammer, Craftsman heavy- and light-duty, Bostitch T-5, Arrow T-50, Hansen T-1, Swingline 800. See chart for specs.

By GEORGE DANIELS

The fastest gun in the country may be the staple gun. Latest models are driving fasteners in new ways and new places at speeds other tools can't touch. On a roofing job, the hammer types can cut working time in half. Special guns beat any other means of anchoring wire or cable. On ceiling jobs, where staplers have always made quick work of locking tiles to furring strips, they've gone one better: They've eliminated the furring strips. They speed the action in upholstery, screening, fencing, and other home chores too numerous to list.

But that's only the beginning. Stapling tools just entering the home-shop field do jobs you never thought a stapler could—they're the muscular big brothers in a family of tools that can come close to building an entire house. To get the most from all this, you should learn to match tool, technique, and staple type to the work you want to do.

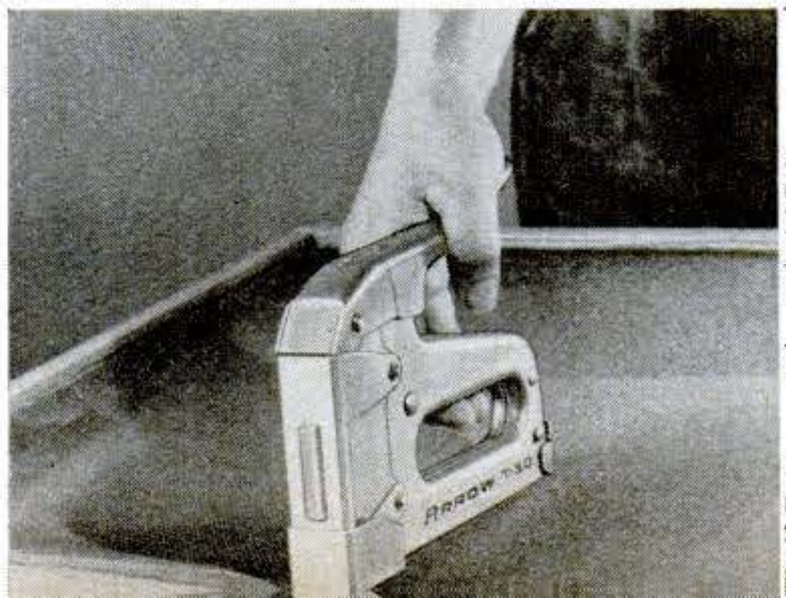
Spring-drive lightweights. They average a little over a pound, take staples up to 5/16-inch leg length (usually .030 wire) and are still the best sellers. They'll fasten insulation, screening, plastic storm windows, and most upholstery—but not ceiling tiles. (Models that take slightly longer staples are sometimes classed as middleweights, but handle roughly the same jobs.) All gain holding power from new, sharper staples with divergent (sawtooth) points. With a magnifier you can see that the points angle in opposite directions. When driven, they take split

Roofing felt goes down fast, stays put, when you attach it with a stapling hammer like this Bostitch H2B. Heavier type drives 3/4" staples for asphalt shingles.

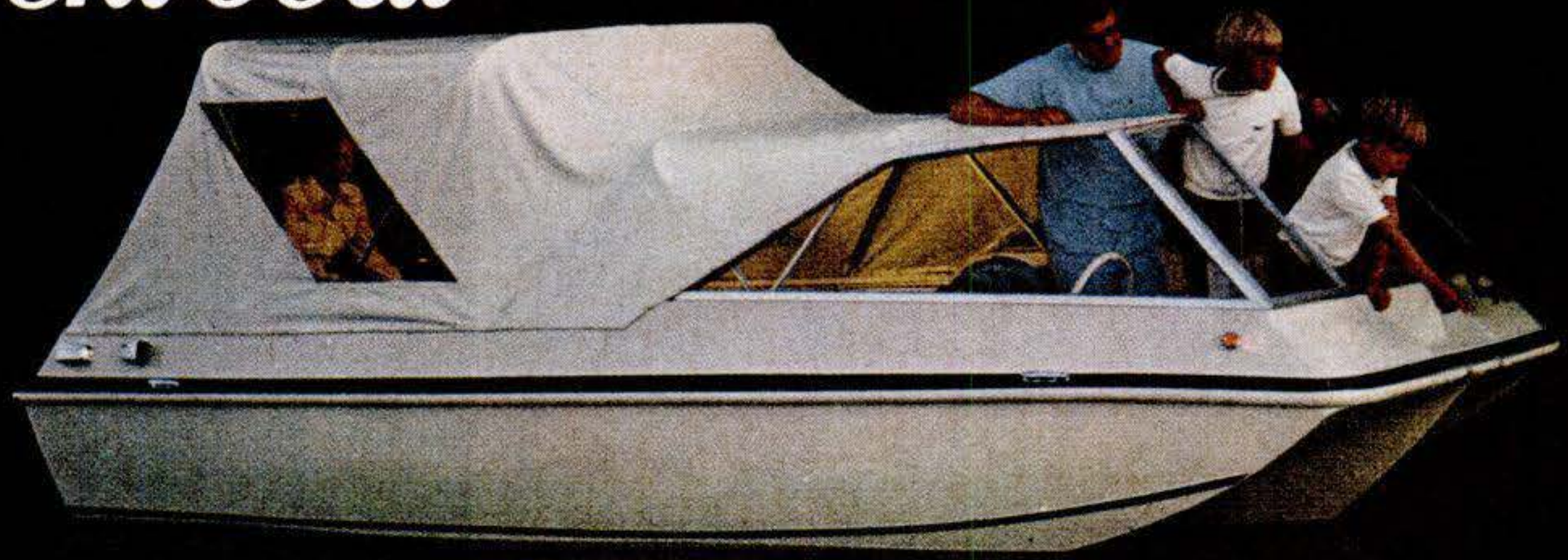
Stapling burlap around trees or shrub stakes provides a winter blanket. On trees use one or two 3/8" staples at start and finish of wrap; they make minimal puncture.

Tacking screen to window frames is easy with special attachment to bite screening so you can draw it taut before firing staple. Molding can be stapled, too.

Radiant-heat cable is best attached to ceiling base with special gun, such as this Bostitch T5-8W Radiant Tacker. Staple is shaped to fit over wire.



Hot new ski boat



18' Shark Camper 195

Don't let looks fool you.

Larson's new Shark Camper will get the whole family up on skis. And keep them there. All day.

She'll power out with speed to spare. Or just putter along, lazily and leisurely.

Shark will take you right into the middle of those hidden fishing nooks—where you can drop lines from all four sides.

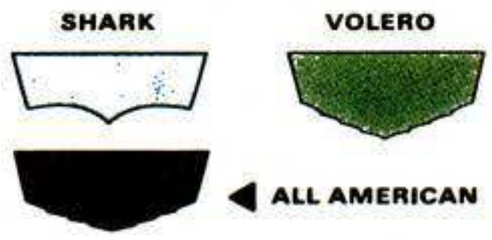
She'll go anywhere, anytime, in any kind of water. Shark's tough tri-hull softens the roughest rills . . . *quietly*, thanks to Life/Guard.

And, when day's done, just pop up Shark's top and she's a cozy comfortable cabin with lots of room. Complete with galley and dinette, if you like.

The '70 Sharks are available in standard models, too—from 14 to 18 feet, outboards and comboards. At prices much less than you'd expect for boats that offer so much. (Such as Larson's "unextras" including Life/Guard Construction.*)

If you're going to discover the great outdoors this year, do it *close up*... in a Larson Shark Camper, the hot new ski boat that sleeps four.

There's a Larson hull for your kind of boating:



Shark Tri-hull — Spacious, stable, versatile, fast.

All American Modified Vee—Traditional Larson Lapline with smooth Million Bubble Ride.

Volero Deep Vee — High performance in roughest waters.

*Patent applied for

***SAFER**—Life/Guard puts flotation high in the hull; your new boat is virtually unsinkable, untippable even when filled with water.*

***QUIETER**—Life/Guard absorbs vibration, muffles sound; runs so smoothly and quietly you can actually hear the difference.*

***STRONGER**—Life/Guard is an integral part of the hull; your new boat is tougher, shrugs off punishment better than ever before.*

Larson

LIFE/GUARD

Larson Boats, a Division of Larson Industries, Inc.
Minneapolis, Minnesota 55436
Little Falls, Minn., Nashville, Ga.

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1970 Mercury Thunderbol designed

New Thunderbolt ignition in every 1970 Mercury.

Breakerless Thunderbolt (no points at all) from the 135 down through the 40 hp. Mercs from 20 through the 4 hp have new *Maker-Point* Thunderbolt: the plug is fired by the points making contact. This reduces arcing and increases point life. Result: points used in the Mercs from 20 hp down are designed to last the life of the engine. Both systems are capacitor-discharge type and have the incredibly fast Thunderbolt rise time, which zaps up to 40,000 volts to the spark plugs in microseconds. With Thunderbolt, Mercury continues to have the fastest, hottest spark in the industry —fastest, surest starts for every Mercury in the line.

135 hp. That's right. 135 hp.

Sleek slim powerhouse—world's most advanced family outboard. Mercury's exclusive 6-cylinder in-line design. Direct Charging and Thunderbolt ignition. With an engine no larger than last year's 125 hp, the Merc 1350 gives you all this additional power, plus amazing fuel economy. And it has all the engineering integrity you expect from Mercury. New Merc 1350—nobody else even comes close.

Four new Direct Charging Mercurys. Two sixes, a four, a two.

In addition to the 6-cylinder Merc 1350, three more Mercs for '70 feature Direct Charging: the 6-cylinder Merc 1150, the 4-cylinder Merc 800, and the 2-cylinder Merc 400. Technically, what happens inside a Direct Charging Mercury engine is this: the unique design of the transfer passages, inlet ports and piston shape gives precise contro of the incoming fuel-air charge for most efficient cylinder filling and elimination of exhaust gases, giving

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gnition–with spark plugs
o last the life of the engine!

emendously increased power and efficiency. Coupled ith Mercury's Thunderbolt ignition system, this produces ore horsepower per cubic inch—more miles per gallon— ore horsepower per pound—more horsepower per dollar. ut very simply, Direct Charging means a lot more ower in a lighter, more compact package, with less vestment and lower operating costs. Again in 1970— Mercury exclusive.

ew Perma-Gap spark plugs designed o last the lifetime of the engine.

ith ordinary spark plugs, the center electrode is radually eroded away by the spark. Now Kiekhaefer ngineers have come up with a new, super-tough metal loy for the center electrode that resists spark erosion. nder normal operating conditions, your new Perma-Gap park plugs will last the lifetime of the engine. Hard to elieve, but it's true. All new 1970 Mercurys are equipped ith Perma-Gap spark plugs. Another Kiekhaefer engineering first and a Mercury exclusive.

Thunderbolt ignition and Perma-Gap spark plugs prevent spark plug fouling and preignition due to lead deposit. Because of this, you can now take advantage of the wide availability and uniform consistency of regular automotive gasoline recommended for every model in the 1970 Mercury line.

See your Mercury dealer now. Pick up your copy of the exciting new Mercury Catalog. You may just want to put your order in early. And avoid the rush. Because—for 1970— it's going to be a Mercury year all the way.

KIEKHAEFER MERCURY

FIRST IN MARINE PROPULSION

COMPLETE RANGE OF POWER: 4, 7½, 9.8, 20, 40, 50, 65, 80, 115, 135 HP.
For Nearest Mercury Dealer, see the Yellow Pages under "Outboard Motors."
Kiekhaefer Mercury/Fond du Lac, Wisconsin/Canada, Ltd./Australia Pty. Ltd.

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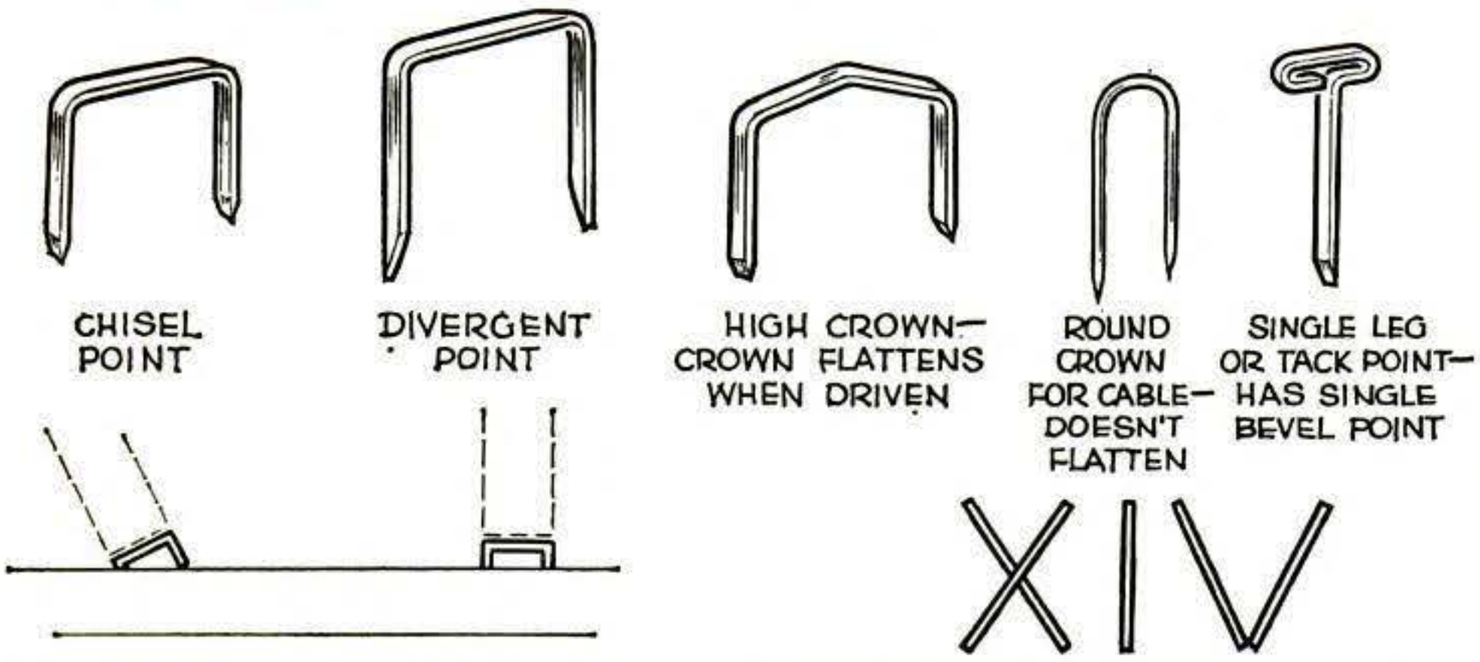
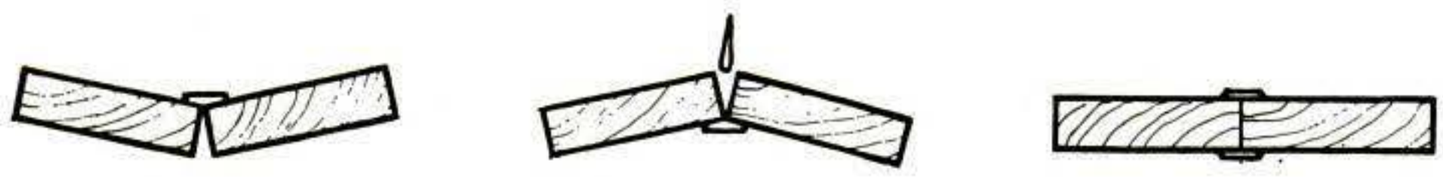
STAPLES — types and tips

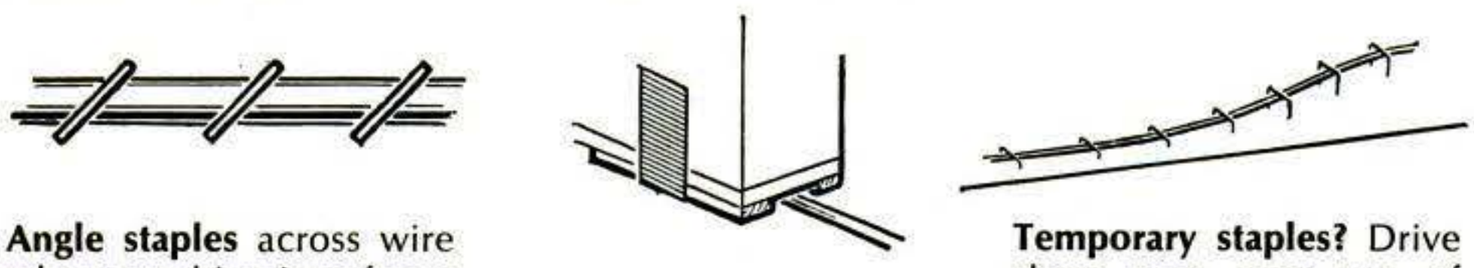


Replacing window panes? Use staples instead of glazier's points. With light gun, drive staple at angle (left); with heavy-duty, hold gun 3/16" from sash.

To index screens or storm sash—so you can match them to the right window next year—number them in order, driving staples to form Roman numerals.



For edge-glued or miter joints, tilt members to form gap at back as you drive staples across joint. Flip work and spread glue in gap, close and staple open side. First staples are sprung, keeping joint snug until the glue sets.



Angle staples across wire when attaching it to fence posts with all-purpose gun. This brings legs as near wire as possible.

Protect insulation on bell wire by taping cardboard strips under stapler.

Temporary staples? Drive short ones over run of wire, pull up to remove—as when anchoring fabric for resin-bonding to boat.

paths for a locking effect. Swingline's Power Dot also provides deeper drive for lightweights. Press your thumb firmly on this dot atop the drive housing as you fire a staple, and you get better penetration. Your thumb pressure eliminates the upward gun bounce, so all the drive-spring force goes to the staple. (The trick works on dot-less makes, as well.)

Budget-priced lightweights may take only one staple size; others take two or three. For varied work, the extra sizes justify the higher price. Examples: for upholstery, 5/16-inch staples provide needed holding power; but for temporary fastening—as for holiday decorations—a 3/16-inch size means easier removal.

If you're likely to carry the tool in your pocket, choose a gun with a handle lock-down to keep it compact and guard against accidental firing.

Heavy-duty guns. As shown in our chart, the bigger tackers now drive from five to seven staple sizes (usually .050 wire) with points to suit specific types of work. These tools do everything the lightweights do, plus major jobs like tiling ceilings and installing wiring and cable. But they weigh more (typically over two pounds) and require more squeeze-power to compress their drive springs.

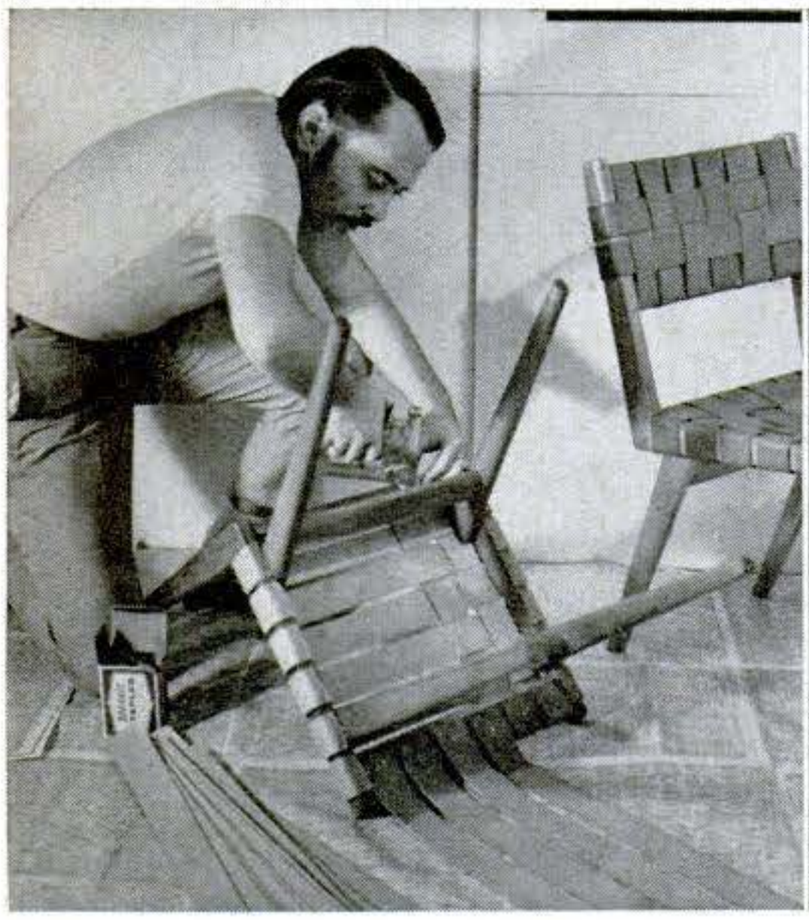
Variable spring power to match the work is available on some new models. Bostitch and Hansen do it with interchangeable springs, Craftsman with a pressure-adjustment button. Lighter pressure for light work spares the hand muscles. A new handle action is also used on the Craftsman gun: A hand squeeze pulls a lower level upward rather than an upper level downward. One advantage: On ceiling jobs you can hold the inverted tool more firmly against the work. This feature also steadies the tool for the new piggy back stapling technique that fastens tile directly to gypsumboard ceilings without furring strips. The trick here is to fire a staple through the tile flange and then, without moving the tool, fire a second staple on top of the first one. The legs of this second staple are deflected outward by the rounded corners of the first one. The resulting hook-grip is so firm the tile will break before the staple lets go.

Outward clinch. This type of gun gets a similar grip with a *single* staple —but not in materials as tough as gypsumboard. It can join soft materials such as fiberglass duct insulation, almost as stitching does. Fire the right staple into corrugated cardboard and its legs spread and hook so quickly they never come out the other side. If your use for such special-purpose staplers is only occasional, look for them at tool rental shops.

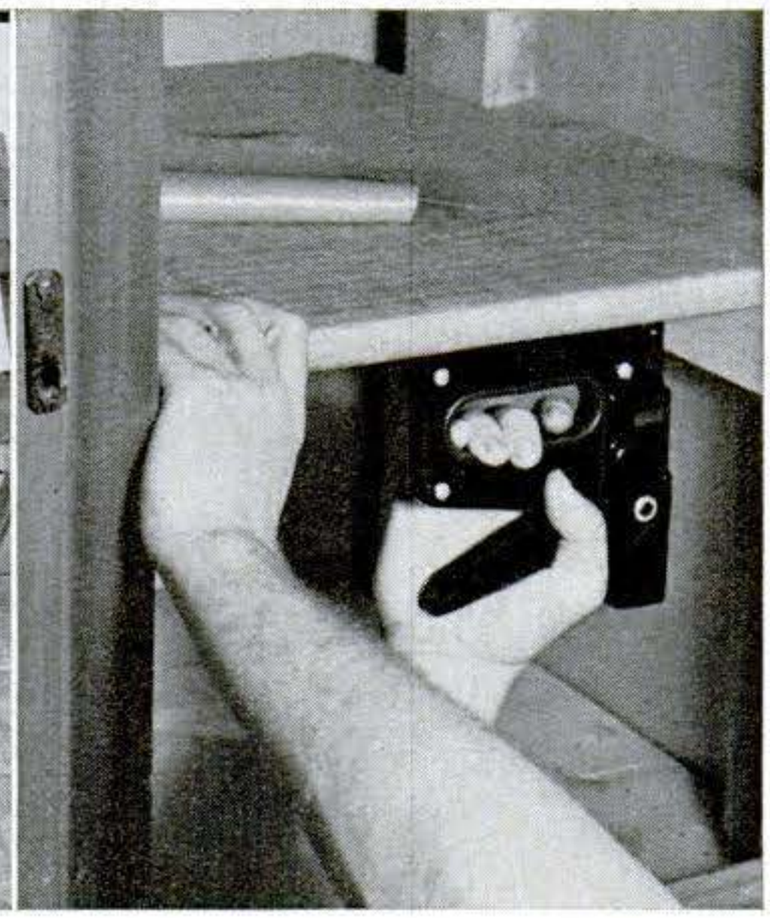
Wire and cable staplers. These are channeled at the base to fit wire or cable. Some, like Markwell's L3, have attachments that adapt them to sizes up to 3/8" Romex. The channeling keeps you from stapling *through* the wire, or stapling too tightly against the insulation.

The staple width of most home guns is enough to span TV aerial lead wire and low-voltage types such as bell-wire and hi-fi or intercom lines. The code taboos stapling extension cords.

Continued



Rewebbing a chair? Duo-Fast's CT-859 loaded with 3/8" staples made fast work of attaching thick leather strips to walnut frames. Three staples at each end did it.



Shelf liner is easily tacked to wooden shelving with a compact gun—here Bostitch's T-5. Either heavy paper or oilcloth makes it unnecessary to sand or finish the shelves.

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Topless Power

It's what all the smart boats are wearing this year.

*For 24 months after purchase, OMC Stern Drive will replace to the original purchaser of an OMC Stern Drive any part of its manufacture, which upon inspection proves to have failed in normal use due to faulty material or workmanship.

It's what gives that bold clean look from bow to transom. Fastback OMC Stern Drive is the go anywhere, do anything style that boats everywhere are swinging with. And the power is topless—topped by nothing in its class. Up to 210 stampeding horses that let you toss off your shackles and do your own thing. You can hit the impossible beaches with OMC's 10° higher power tilt. You'll make a clean get-away from the most jammed up situations thanks to OMC's 30° sharper turning radius, port to starboard. Fully electric power shift. And at full power, vibration and noise won't shake you up because of OMC Stern Drive's unique system of "vibration absorbers." All the extras at no extra cost—plus the only two-year warranty* in the stern drive field. Express yourself—now.

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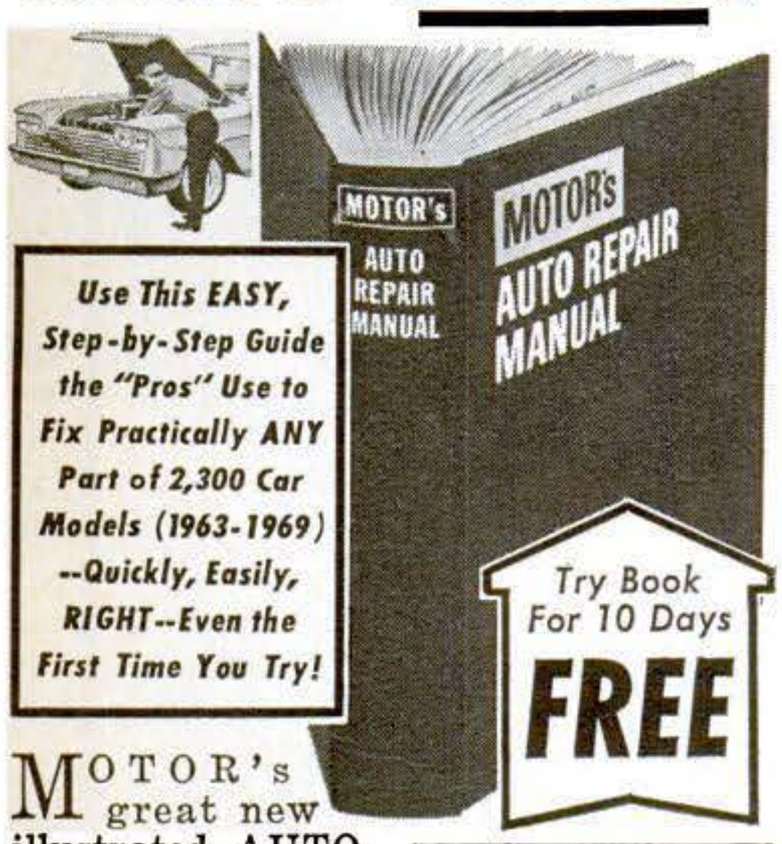
HOW TO FIX CARS *Fast!*



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Reach for Your Staple Gun

[Continued from page 118]

Stapling hammers. Now sold at home-shop prices, these tools give you a wider reach from your working position and cover more area faster in roofing and insulation work. But they're not suited to ceiling jobs or precision stapling, as for screens or wiring. Since the power comes from the swing, not a spring, the tool drives a staple snug with each hammer blow.

Mallet drive staplers. Once strictly for the pros, these are now entering the home field. Since they get their power from the mallet swing, they can drive staples up to 1⅝-inch long for sheathing and underlayment, cutting work time in half. We list two examples in the chart below. PS

STAPLING TOOLS FOR HOME OWNERS

MAKE AND MODEL	STAPLE SIZES	FEATURES	PRICE
Arrow T-50	¼", 5/16", ⅜", ½", 9/16", plus Ceiltile (special—for ceiling tile)	Heavy-duty; all chromed steel; visible refill window; removable channel for easy cleaning	$12.95[1]
Arrow T-55	All T-50 sizes and types, above	Intermediate-duty gun	9.95
Arrow JT-21	¼", 5/16"	Light-duty gun; handle lock; built-in staple remover	5.95
Arrow T-25 wire tacker	Round-crown staples with 9/32", ⅜", 7/16", and 9/16" legs	For wire up to ¼" dia.; tapered head for tight corners; drive blade stops short, can't damage insulation; grooved guide positions wire; rear-loading, precision-locked	18.00
Arrow T-18 wire tacker	Round-crown with ⅜" leg only		18.00
Arrow T-75 wire tacker	Round-crown with 9/16", ⅝", and ⅞" legs		18.00
Arrow T-50 OC (outward clinch)	⅜", ½", and 9/16"	Shoots flared staple to lock inside soft material; setscrews adjust curl of legs	20.00
Arrow HT-50M hammer tacker	All T-50 sizes up to ½"	Sure-grip, shatter-proof handle	18.50
Bostitch T-G3	¼", ⅜", ½"	Medium-duty; snub nose for tight corners; grip-grooved handle	8.95
Bostitch T5-8	5/32", 3/16", ¼", 5/16", ⅜", 9/16"	Front-loading, heavy-duty; interchangeable drive springs to vary power; models for piggyback, cable, outward clinch up to $16.85	13.95
Bostitch H2B hammer	¼", ⅜" (H2BR ⅜" only)	Light nailing jobs; shock absorber	20.75
Bostitch H4 hammer	¾" flat wire	Heavy-duty—can handle roofing	33.95
Craftsman 6847 (Sears)	¼", 5/16", ⅜", ½", 9/16" (latter avbl. with chisel points for piggybacking)[2]	Dual-compression with shift-lock; up-pull handle	10.99
Craftsman 6844	Same as above	Standard handle action, no shift lock	8.99
Craftsman 6846	5/16"	Lightweight (under 1 lb.)	4.49
Duo-Fast CT-830	¼", 5/16", ⅜" light wire	Satin-chrome finish; snap-off jaw for easy cleaning; handle hold-down clip; follow-through drive	10.00
Duo-Fast CT-859	¼", 5/16", ⅜", ½", 9/16"[3]	Heavy-duty model with all above features, plus screen-stretching and piggyback attachments	12.50
Duo-Fast HT-550 hammer tacker	3/16", ¼", 5/16"	Nickel-plated steel; automatic feed; back-end loading; holds 168 staples	15.25
Duo-Fast HT-775 hammer tacker	⅜", ½", 9/16"	Heavy-duty model, with all above features	18.50
Duo-Fast ST-18 strike tacker	⅞", 1", 1⅛", narrow-crown 18-gauge galv.	For installing underlayment; operated with mallet; base guide controls nailing position; holds 120 staples	50.00
Hansen T-1	3/16", ¼", ⅜", ½"	Staples have single leg, like T-headed nail with chisel point	14.00
Hansen T-49	5/16", ⅜", ½", 9/16"	Regular staples; heavy-duty model. Others avbl. from $12.95; all come with cleaning tool	17.00
Markwell L3	11/64", ¼", 5/16", 7/16", ½", 9/16" (5/16" & 9/16" avbl. in bronze)	Uses six sizes, 12 types of staples; models avbl. for screening, window shades, outward clinch, plus cable from 5/16" to ⅜" including Romex; at prices to $18.50	13.25
Markwell MH-33 hammer tacker	11/64", ¼", 5/16", 7/16", ½", 9/16"[4]	All-purpose; staples avbl. in carbon steel, bronze, tinned copper and cement coated; front-loading	18.95
Swingline 101[5]	¼", 5/16"	Power dot, handle lock, staple extractor	5.95
Swingline 800[5]	¼", 5/16", ⅜", ½", 9/16"	Power dot, handle lock, staple extractor	8.95[6]
Swingline 900	¼", 5/16", ⅜", ½", 9/16" Staples for above Swingline models avbl. in monel and Loktile for ceiling tile	Red reload signal shows when supply is nearing end; movable stabilizer keeps gun level; handle locks	12.50
Spotnails[7] Multi Tak	⅞" leg, 3/16" crown	Free 14-oz. mallet; drives 68 staples without reload; one blow drives staple for carpet tacking, wood trim, weatherstrip	12.00 to 15.00

NOTES: 1. Kit including gun plus attachments for screen, shades, cables, staple extractor, and 5,000 staples in three sizes: $18.25. **2.** Three Sears models take either Craftsman or Duo-Fast staples. **3.** Duo-Fast's outward-clinch model OC-5018 drives only ⅜", ½", and 9/16" wide-crown staples, mainly for fastening insulation covers around pipes, ducts. **4.** Markwell MH-44 hammer tacker takes round wire staples up to ½", also avbl. in monel. **5.** Montgomery Ward's two Power Kraft staplers with these model numbers are basically the same tools. **6.** All-chrome model (800-X) is $9.50. **7.** Spotnails is the industrial division of Swingline.

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For sale: mansion with pool.

Chieftain Aluminum Cruiser

Schedule a cocktail party
in the Bahamas next Friday night.
Another Great Escape
Machine From Starcraft.

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BANGOR PUNTA'S WIDE WORLD OF BOATING
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AERO MARINE equipped ®

Drop us a line...

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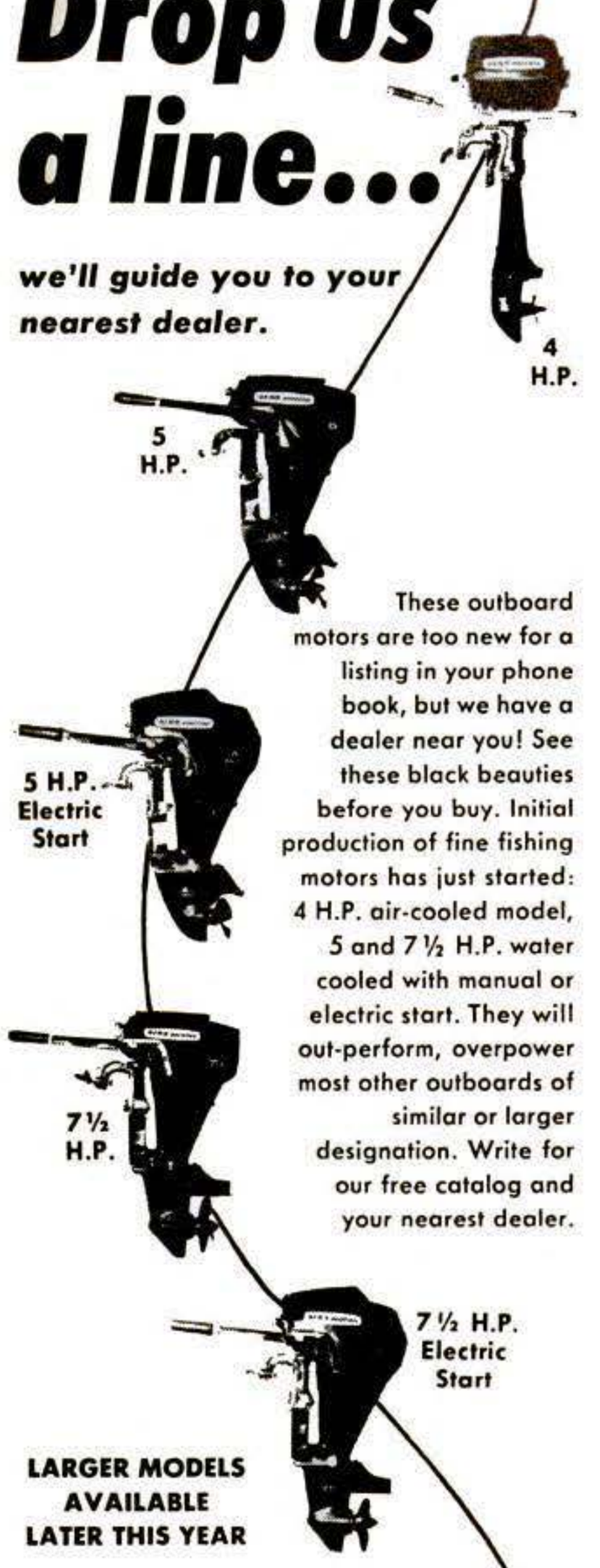

These outboard motors are too new for a listing in your phone book, but we have a dealer near you! See these black beauties before you buy. Initial production of fine fishing motors has just started: 4 H.P. air-cooled model, 5 and 7½ H.P. water cooled with manual or electric start. They will out-perform, overpower most other outboards of similar or larger designation. Write for our free catalog and your nearest dealer.

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Aero Marine inboard gas and Diesel engines are leaders in the field. The same expertise now brings you outboard motor values unsurpassed by other production models.

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DEALERS: INQUIRE ABOUT AVAILABLE AREAS

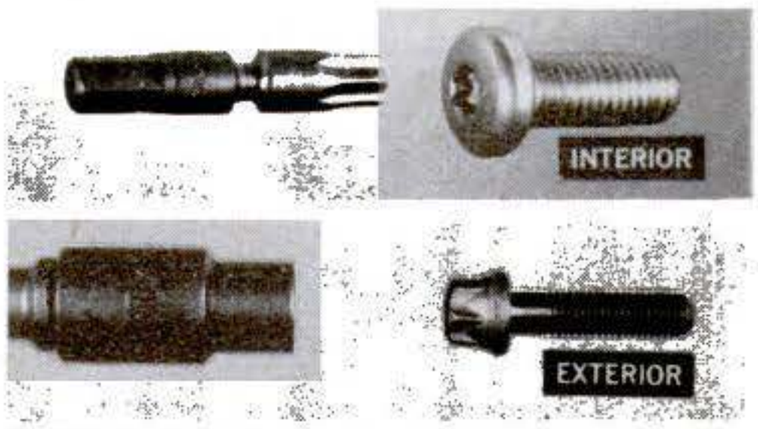
SHOP TALK

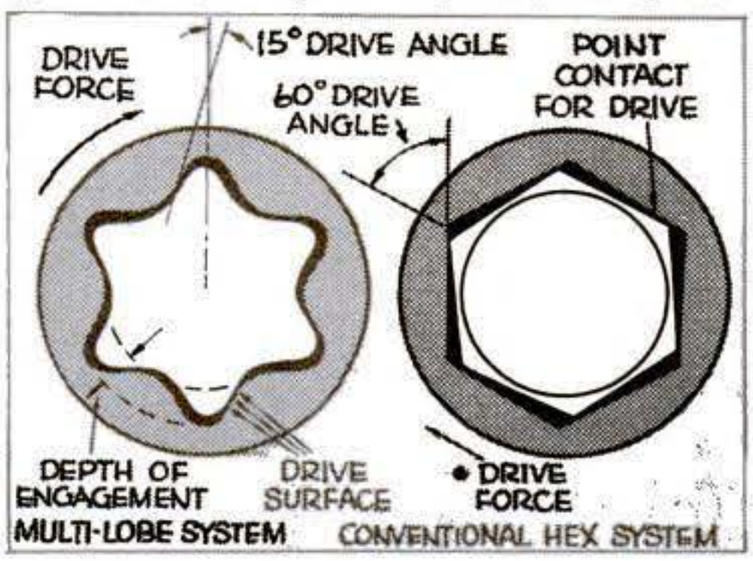
By ROBERT P. STEVENSON

Check those 1970 cars for a new type of fastener

You know how frustrating it can be if you round the corners of a hex nut. This may occur less frequently now. A new hex-lobular (six-lobe) system gives longer life to *both* fasteners and wrenches. You may encounter the new fasteners, internal or external, in this year's cars. All American auto manufacturers are trying the system, to some extent. Introduced by Camcar Screw & Mfg. Co., Rockford, Ill., Torx fasteners are made by at least 16 companies. Apex Machine & Tool Co., Dayton, Ohio, makes driving tools to fit them.

A hex system (sketch) transmits force through corners, and these wear. Torx force spreads out, giving longer life. Less wrenching effort is needed, because the driver doesn't cam out.





More Plexiglas available

Plexiglas acrylic plastic has been around since the middle thirties. However, you couldn't always find it. The maker, Rohm and Haas, has now set out to make it more readily available. Word has come to me that you can now expect to buy it, with little or no wait, at building-supply dealers, hardware stores, and paint stores. The familiar clear stock will be available in small sizes—18" by 24", 26" by 26", and so on, in thicknesses of $\frac{1}{10}$", $\frac{1}{8}$" and $\frac{1}{4}$". Striking colors also are on the list—red translucent, white translucent, blue translucent, black opaque, bronze transparent, amber transparent, and blue transparent. Colors come in one thickness, $\frac{3}{16}$", in 48" by 72" sheets. Prices range from $1.60 to $2.50 a square foot for clear, 10 percent more for colored.

A full-color illustrated brochure, "Do It Yourself with Plexiglas Acrylic Sheet," is available from dealers. You can also get it by sending 25 cents to Rohm and Haas Co., P.O. Box 9730, Philadelphia 19140.

Cats come home. But how about those borrowed tools?

All right, you home-shop owners who prize your tools. Here's news: You can now do something about the tools friends and neighbors borrow—and sometimes forget to return. You can send for an 8½"-by-11" copy of the humorous poster illustrated here. When you get it, post it in your home shop—right over your workbench.

I saw a note about the poster some time ago in *Flying Chips Magazine*, an informative publication put out six times a year ($1.75 a year) by the Power Tool Division of Rockwell Mfg. Co. I asked Editor A. M. Warkaske if POPULAR SCIENCE might also offer the chart to readers. He agreed, and it's free for the asking. Write to Flying Chips, Power Tool Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 15208.

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The action's beautiful with this Model II fiber glass rod. And the rod's perfectly matched and balanced to the reel.

There's less line wear and smoother pick-up with this stainless steel line guide. It revolves as you retrieve.

You won't get caught short of line with this reel. It's filled with 250 yards of 8-lb. test monofilament.

This reel's geared for power. The big ball bearing-mounted helical gear system can handle the biggest fish.

No problem packing this reel away. Both bail and handle are fully collapsible.

Ted Williams and Sears proved it:

A spinning reel that lands the big ones doesn't have to cost a lot.

This check mark and signature certify that Ted Williams, Chairman of the Sears Sports Advisory Staff, personally tested and approved this rod and reel.

Just because a reel doesn't wear a fancy price tag doesn't mean it can't be great. Ted helped Sears prove it with this one.

They came up with a reel that has an adjustable drag system made of six metal and Spinron™ discs that acts like an automatic pilot. When a big fish takes off and really puts the pressure on, the drag takes over. Automatically keeping the proper tension on your line. So more of the big ones end up on your stringer and not with your lures.

Six-disc drag, powerful helical gear system, huge line capacity—they're just a few of the many great ideas Ted and Sears packed into this reel.

Yet it costs under $17. There's nothing like it for that kind of money.

Tomorrow, check out this Ted Williams Model 410 spinning reel. Ultra-light and salt water models are also available. See them all at the Sears Sports Center in a Sears, Roebuck and Co. store. Or look in the Catalog.

where the new ideas are

NEW FREE FISHING CATALOG

For your FREE copy of Sears 1970 Fisherman's Catalog, mail coupon to Sears, Roebuck and Co., Dept. 139, 925 S. Homan Ave., Chicago, Illinois 60607. Q6

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[Continued from page 53]

sence of drip rails over doors, and special stiffening of the inner roof panel are body innovations.

But perhaps most of the excitement lies in the GMini's engine—the first die-cast aluminum four-cylinder OHC engine ever built here for mass production. There's a weight saving of 50 pounds with use of Reynolds 390 aluminum instead of cast iron in the block. But the most startling innovation is the use of bare aluminum cylinder walls! The Buick-Olds aluminum V-8 of 1960-63 had cast-iron cylinder liners. The GMini engine's pistons are aluminum, but have an iron coating to provide the same iron-to-aluminum friction surface (only in reverse).

How much power? Displacement is 140 cubic inches, and Chevy engines typically deliver 7/10 hp. per cubic inch in basic form. That means a minimum of 100 hp. for this 1,900-pound car, promising outstanding performance. The 1,808-pound VW has only 53 hp. A key to high power potential in the GMini is the 6,000-plus rpm limit, made possible by the overhead camshaft.

Ford is hot on Chevy's tail. The Pony, a two-door fastback, has a conventional trunk lid, with fuel tank and spare wheel stored below the trunk floor. Ford tried to make the Pony a three-door sedan, but found that body rigidity would be lost unless they added a heavy crosspiece below the backlite, so the idea was dropped.

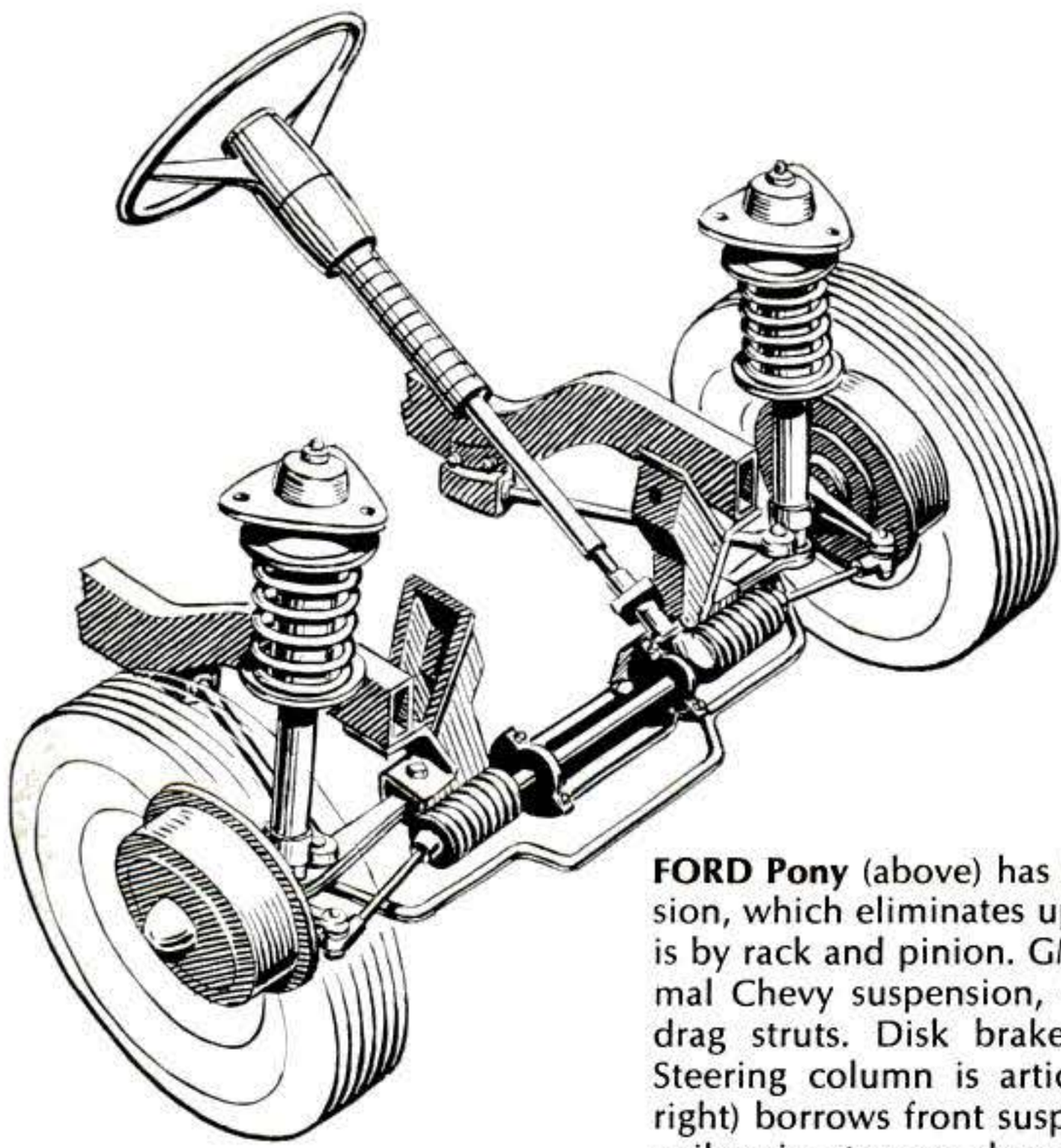
The Pony engine is lightweight cast iron with canted valves in a crossflow head for high efficiency breathing and an overhead camshaft that allows a high rpm limit. Displacement is 122 cubic inches, and it puts out some 86 hp. in basic form.

AM leads with the Gremlin. American Motors is surprising everybody by its amazing ability to develop new car concepts and get them into production quicker than bigger rivals with far greater working capital.

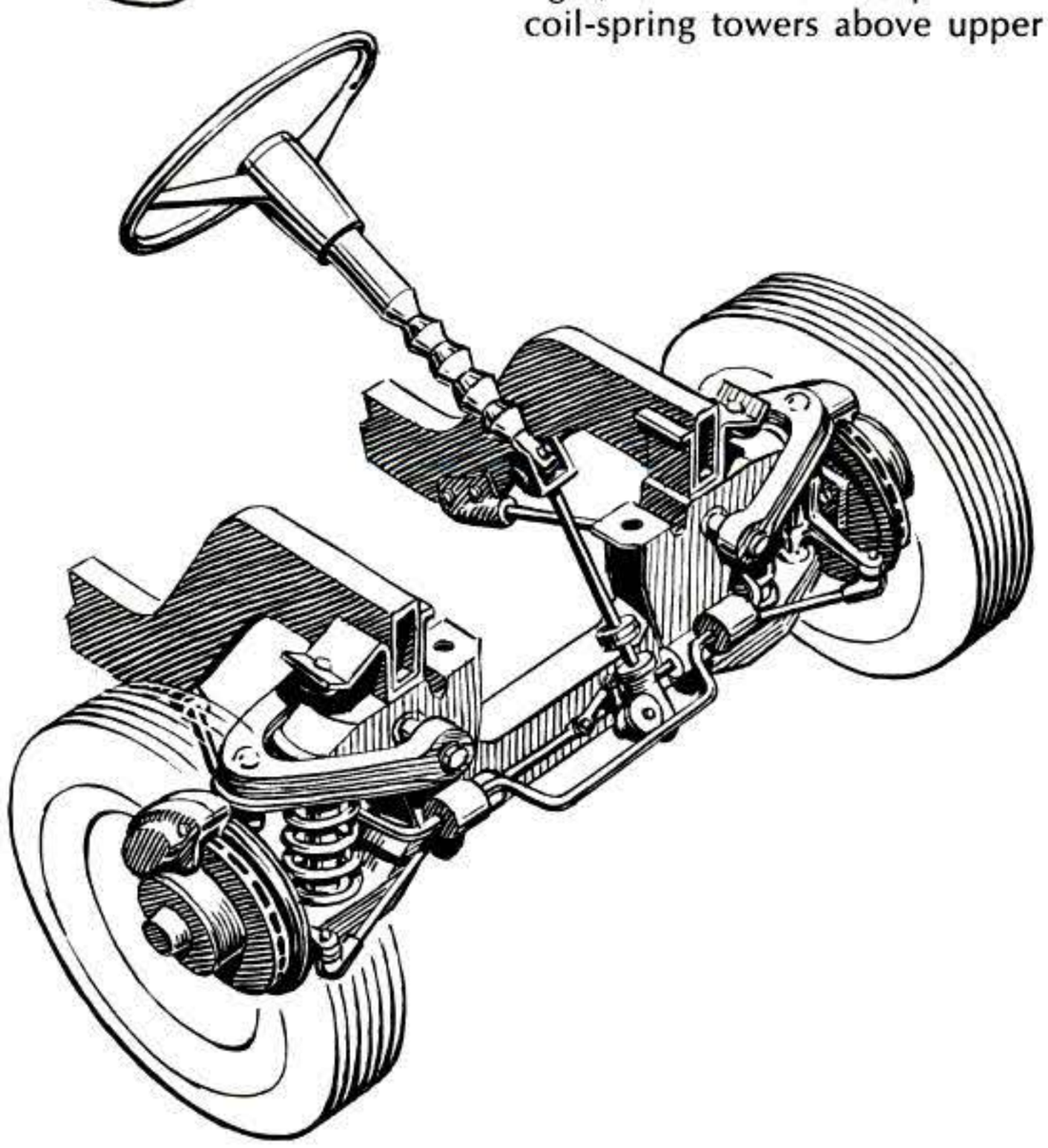
Using the same long-wheelbase-but-short-length formula that produced the Hornet, AM has readied an all-new small car six months ahead of GM and Ford.

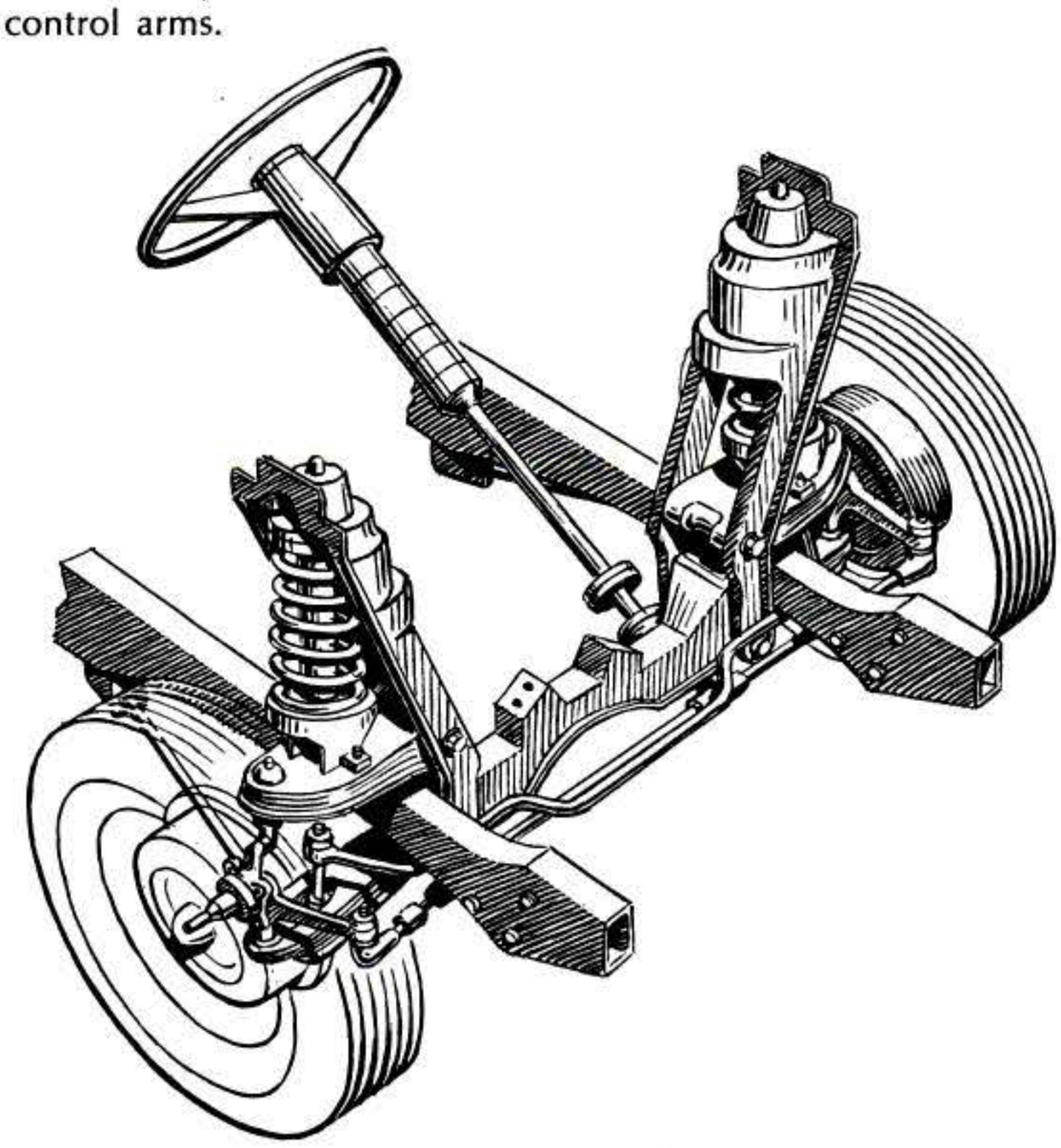
How did they do it? Forward of the windshield, the Gremlin is almost a duplicate of the Hornet. The basic Gremlin is a two-seater, with optional back seat. The third-door concept is applied here, too, but only the top of the rear panel swings open. The bottom half is fixed. For power, the Gremlin has it all over its rivals. The standard engine is the Hornet's 199-cubic-inch six, the 232 six is optional.

AM hopes to come in with a base price as low as $1,850 for the Gremlin, while there are indications that GM has rising cost problems and may peg the basic GMini at $1,910 to $1,925. Ford is expected to hew to the $1,900 target, even if it leaves no profit margin. PS



FORD Pony (above) has MacPherson front suspension, which eliminates upper control arm. Steering is by rack and pinion. GMini (below, left) has normal Chevy suspension, except for use of leading drag struts. Disk brakes are standard at front. Steering column is articulated. Gremlin, (below, right) borrows front suspension from Hornet, with coil-spring towers above upper control arms.





FEEL

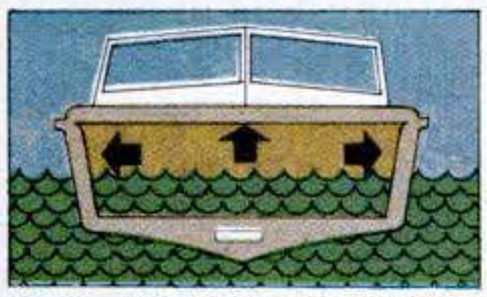
THE STRENGTH

While everyone else is pounding you with performance, Glasspar nudges. Because performance should be gentle, not shocking.

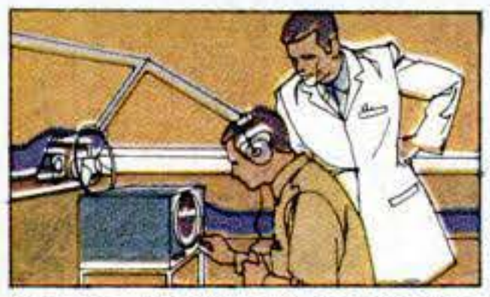
Like the 16′ Cutlas. Lavishly roomy, luxuriously styled. Her subtle beauty belongs in the open water.

Under the rugged tri-hull design is Life/Guard Construction*. That's what makes Glasspar a safer, quieter, smoother riding fibreglass runabout.

Before you buy a boat, take a look at a Glasspar. She's tough but beautiful.



Safer — Life/Guard Construction features a unique foam collar in Glasspar's hull, combined with a "bilge tunnel" to make Glasspar virtually noncapsizeable.



Quieter — Life/Guard Construction reduces engine and water noise. Tests performed in a Glasspar indicate that she is quieter than other fibreglass runabouts.

Stronger — Life/Guard combines layers of fibreglass, foam and additional layers of fibreglass. It makes Glasspar safer, stronger, quieter than conventional hulls.

LGC LIFE GUARD CONSTRUCTION

Glasspar

BLUE WATER BOATS

A Division of Larson Industries, Inc.
Plants in Little Falls, Minn. / Nashville, Tenn.

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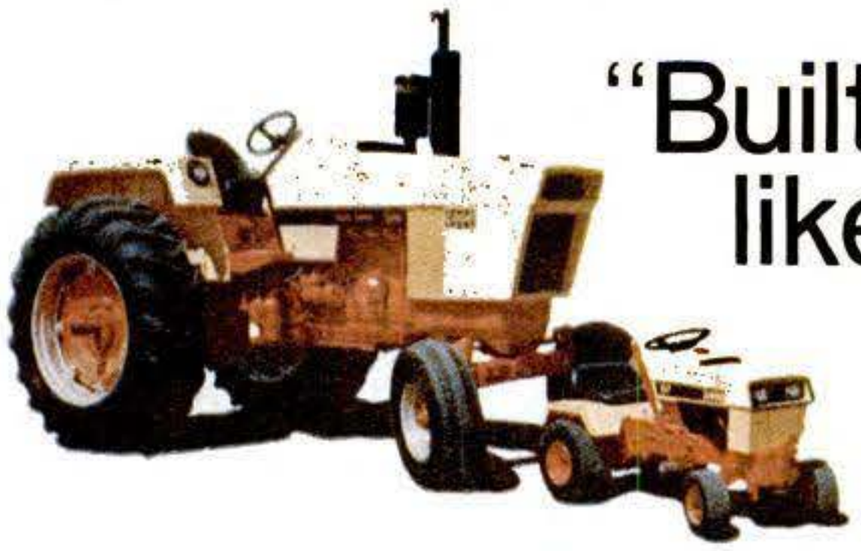
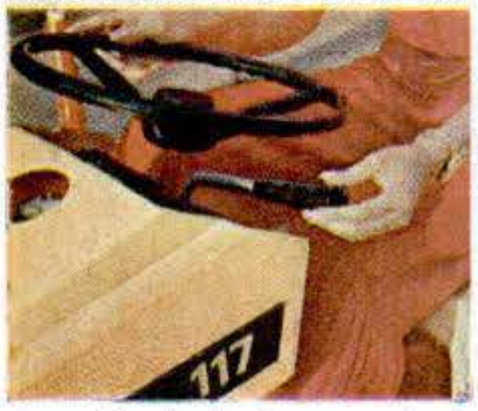


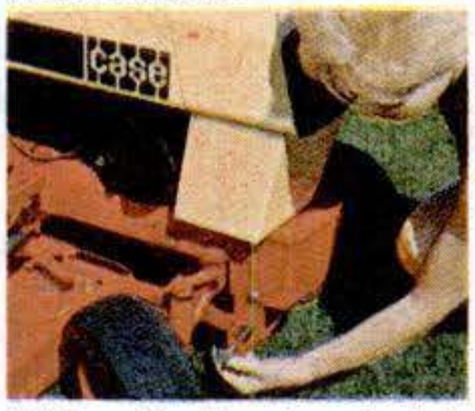
"Built like the BIG ONES!"

MEET THE NEW 7 HP low-cost mechanical and hydraulic drive models from Case. *Real* tractors—engineered and built to provide a choice of dependable hydraulic or gear-shift drive, year 'round performance and service proved in the BIG Case farm and construction equipment. Test-drive a *real* tractor—7 to 14 hp—at your Case Dealer today! J I Case Outdoor Power Equipment Division, 129 So. 1st Street, Winneconne, Wisconsin 54986. A major component of Tenneco Inc.

New 7's Mow 34" at a Pass—velvet smooth



Smooth, single-lever control of direction and speed—no-clutch, no shift, "cushion-control" hydraulic drive.



3 "Snap-Fast" spring pins let you change attachments in less than 2-minutes. No tools! No parts to lose!

The mighty 7 with Case-built snow caster blasts a 32" path through blizzard-packed drifts.

See new 7, 10, 12, 14 hp models at your Case dealer or write for free full-color catalogs today!

case

Bowl for Sunbathing

[*Continued from page 113*]

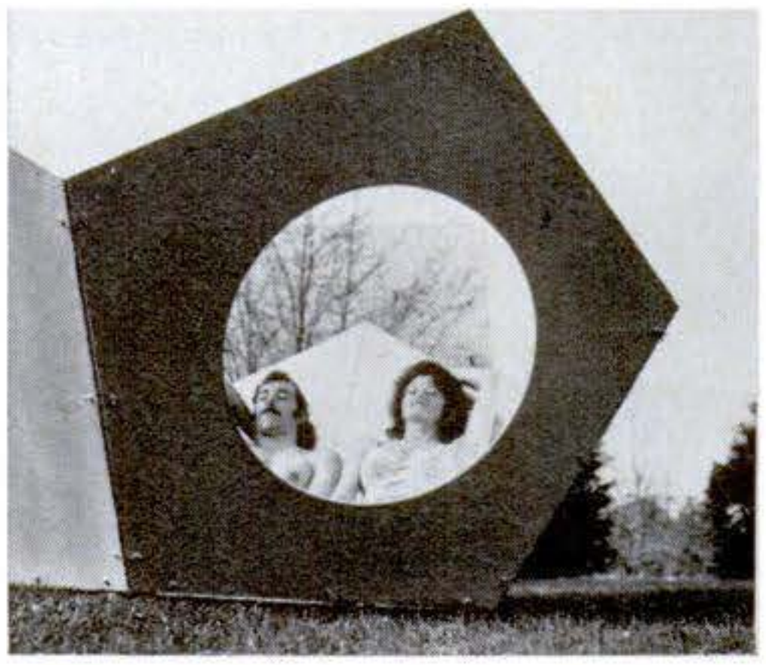
Yours may be different from the ones I used. Check hole location to insure that everything will assemble correctly.

Select one pentagon for the base. Mark 4" from each corner and the center for the ¼" holes which hold the two-by-four blocks or feet. Countersink these holes. Counterbore the support blocks from the bottom for the nuts on the ¼"-by-1½" flathead bolts that secure them to the base.

Spread the corner irons to an angle of 117 degrees with a vise and pliers. Open the first with super accuracy and use it as a template for the others.

Finishing. Give all wood parts a coat of enamel undercoat with brush and roller. Sand all surfaces thoroughly with fine paper. One side of the pentagon (and the edges) can then be finish-rolled with a good outdoor enamel in a bright saturated color. Apply the same enamel to the squares and support blocks.

The reflective surface in the prototype was heavy aluminum foil (paper backed). Cement was brushed on the plywood and the foil rolled on with a medium-hard rubber roller. The technique is like hanging wallpaper.



Bowl access hole in one pentagon is a fine "prop" for taking off-beat family photos.

The foil surface is beautiful but somewhat fragile. You might want to substitute a high-grade aluminum paint for more abrasion resistance and better weathering.

Avoid over-exposing yourself to the rays of the sun. The bowl was designed to intensify relatively weak off-season sun. If you use the bowl during seasonal periods of greater sun activity paint it white inside. Foil may reflect too much sun. PS

PARTS LIST

3 panels 4'-by-8' fir plywood ⅜" thick, good both sides
6 2-by-4-by-3½" pine blocks (feet)
100 sq. ft. paper-backed aluminum foil
30 1" corner irons (inside corners)
60 10-24 r.h. machine screws ¾" long
10 10-24 r.h. machine screws 1" long
70 washers
70 10-24 wing nuts
6¼"-1½" f.h. machine screws, with washers and hex nuts
1 qt. "vinyl" cement

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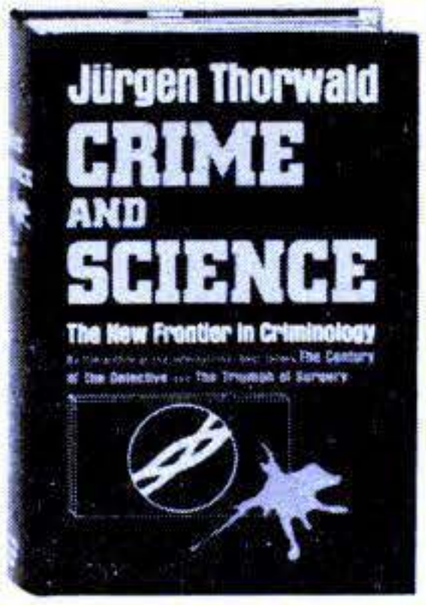

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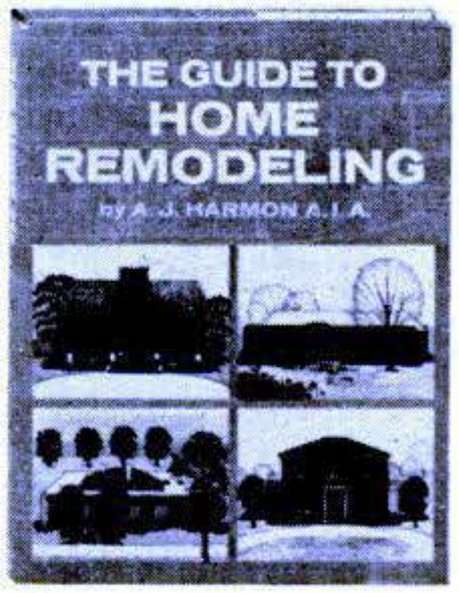

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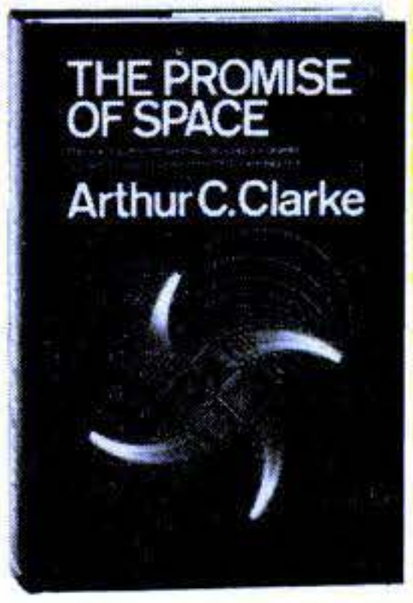

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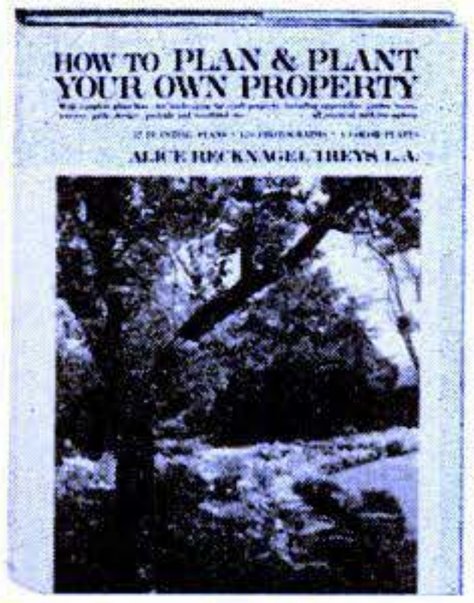

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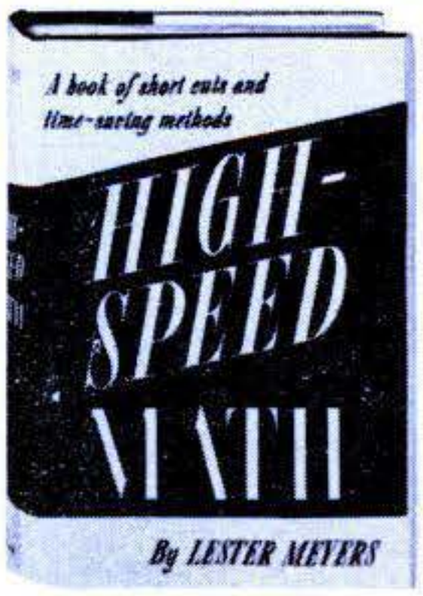

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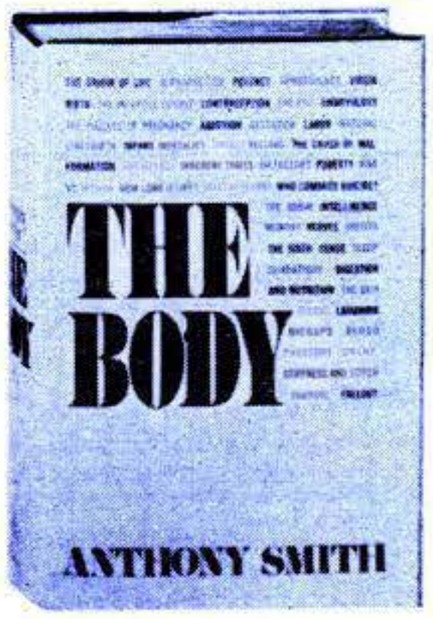

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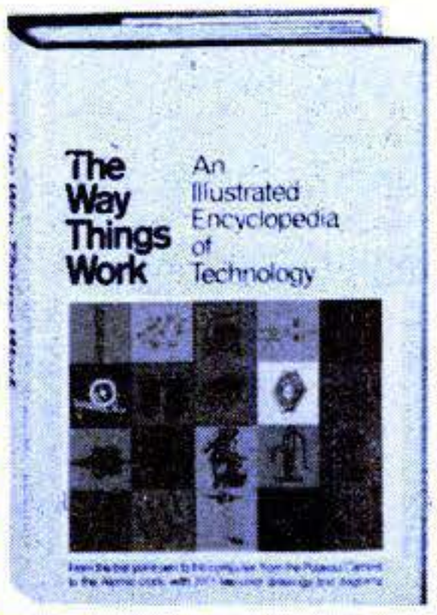

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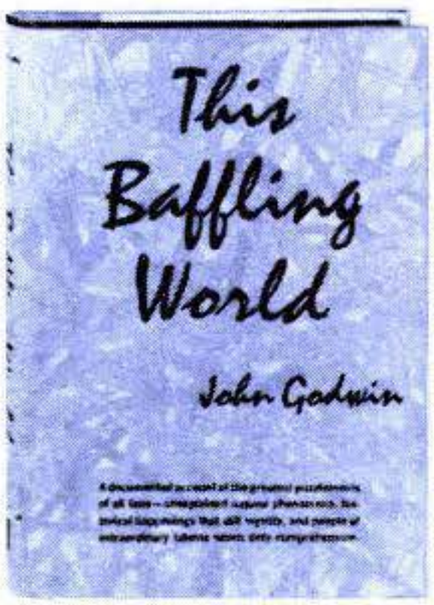

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Scuba Diving for Fun

[Continued from page 51]

Fully rigged diver (left) wears a wet suit, flippers, quick-release weight belt, knife in a leg scabbard, and depth gauge on wrist. Close-up (right) shows a single-stage lung, face mask. Photos were made at Silver Springs, Fla. (where underwater facilities are available only for commercial photography, by special arrangement).

two shallow-water dives in open water. You know how to ditch and don your equipment on the bottom of the pool. You know how to put on a mask in the water and clear it with less than one breath. You have been through harassment in the water and can swim with tanks but without a mask.

You can turn on your own air without panicking after your instructor has turned it off. And you understand the critical nature of a free ascent—that it's absolutely necessary to exhale while ascending. You understand the use of the reserve valve and have a reasonable knowledge of the no-decompression limits of time and depth on your dives. (I strongly recommend that you become familiar with the U.S. Navy's decompression schedules; it's good insurance.)

Your next task is to select equipment. Your instructor can help, and so can the many catalogs offered by various manufacturers of diving equipment. Here are a few guidelines:

Swim fins. If you plan to dive in cold water, you will probably want to wear rubber booties under your fins to keep your feet warmer. That will require a little larger foot size in the fin to accommodate separate booties or the built-in booties on a full wet suit. You won't need the full-foot-model swim fin.

On the other hand, if your beach has warm water but some sharp rocks either above or below the surface, you would be wise to select the full-foot type of fin. Comfort is important, too: a diver is only as good as his fins.

Wet suits. Coverage and thickness determine your suit's effectiveness against the cold. Thicker suits are more expensive, of course, but not necessarily more restricting to your movements. In moderately cold water, a suit that covers only the torso may be sufficient. In very cold water you may also require a hood that covers all of your head except the face. Suits faced on at least one side with nylon are much more easily put on and taken off; they're also more tear-resistant.

Accessories. Many varieties of weight belts are available. Make sure your belt has a quick-release feature and that it is always ready for use.

You will need a life jacket, too. Again, many versions are available and all are good for shallow diving. Take your choice, but *never* dive without one. The same applies to a diver's knife.

Depth gauges are required in deep water, and they're handy to have all the time. Most are reasonably accurate and have a range of 0-200 feet. That's plenty for the sport diver. Keep decompression tables in mind. Decompression timers, available on some depth gauges, are handy; but a good watch and a careful eye on decompression limits is more certain.

A watch is also a must for deep diving. Many are available—some good, some bad. A good diving watch must be certified waterproof to 200 meters (660 feet) to be considered safe at any lesser depth. I use a Rolex.

Face mask. There is a larger selection of face masks available than any other single piece of equipment. They come with built-in snorkels, built-in clearing valves, built-in nose-clearing devices, improved side-vision tinted lenses, and provisions for attaching prescription or demagnification lenses. (Normally, objects viewed underwater through a face mask appear about one-third larger than they really are.)

A good-fitting mask is as important as good-fitting fins. To check the fit, hold the mask against your face and try to inhale—if you can't, and the mask stays in place when you remove your hand, the fit is good. There should be no uncomfortable pressure

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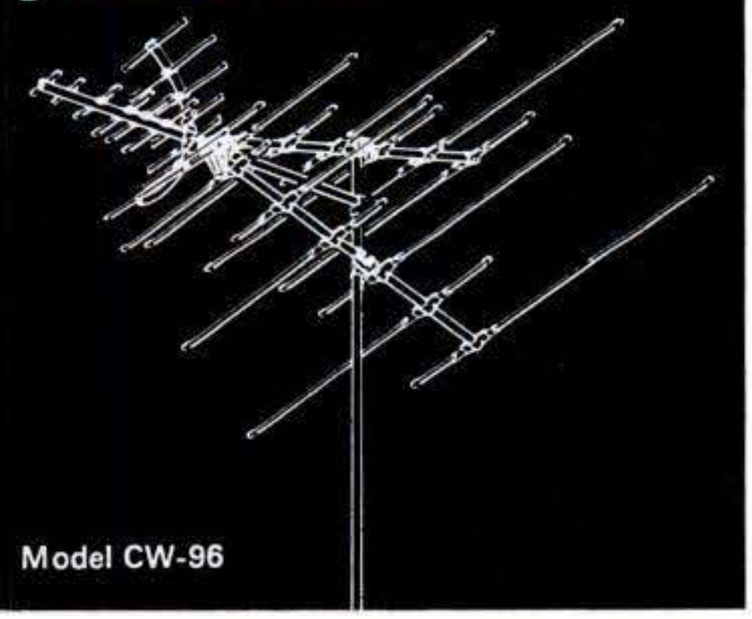

Among other things, Winegard makes a complete selection of special made-for-color antennas. For instance, our sensational Color Wedge antenna.

It not only performs better than any other antenna, it looks better—and definitely different. It has a special electronic design that makes it work better on *all* channels. And it has a very special mechanical design that makes it last years longer, in spite of rain, ice, and high winds.

The unique "wedge" design provides a greatly increased vertical capture area, and in a much shorter, more compact antenna. This means your TV set receives increased signal for sharper clearer reception—even on those weak, hard-to-get channels. And it means ghosts, snow and other TV interferences are drastically reduced.

A special truss construction helps make the Winegard Color Wedge the strongest antenna around. It's permanently weather-protected by the genuine gold anodized finish. And the TV wire connections are protected by the exclusive built-in cartridge housing.

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points, and the rubber should be properly pliant.

Masks, as well as fins and other rubber equipment, should be protected from the sun whenever possible. They will last longer. Also, if you dive in salt water, remember always to wash your gear in fresh water at the end of each diving day. This is mandatory for regulators, tanks, and spearguns.

Spearguns are a fisherman's choice. Main considerations are ease of handling, cost, and size of the fish you expect to go after.

Scuba equipment. In a previous article [PS, Jan. 1969] I discussed various types of underwater breathing devices. At this time, only one type is practical and safe for the sport diver: the open-circuit scuba using air, preferably with a single-hose regulator.

Many innovations have been incorporated into the original Cousteau-Gagnan concept to make breathing easier and to give the regulator a longer useful life. An audible signal is available on at least one model to warn the diver when his air pressure falls below a certain level. This can be very valuable.

A close call. My reserve valve had been placed in the wrong position prior to a dive off Guam a few years back, and when breathing became difficult I pulled the reserve—to no avail. Luckily, we were diving in relatively shallow water and no decompression was required. Otherwise I would have been in "deep" trouble. The audible alarm is nearly foolproof, and I wished then that I had had one.

On the selection of breathing equipment, the best bit of advice I can give you is to check with your instructor or dive-shop manager. Ask to see and discuss all the regulators, tanks, and harnesses made, and decide which features you like best.

Don't try too hard to save money. Good equipment is worth more.

Do take good care of all your gear. This applies particularly to your regulator. If you're sure you know how to break it down, clean, and reassemble it, go ahead. But don't experiment. If you don't *know* how, take it to an expert. Do this at least every three months or oftener—depending on the type and frequency of use. Everything you have in the water with you, including your life, is no better than your regulator.

A few rules. Let's finish with a few rules that I've learned from experience are the most valuable:

1. Learn through reading or talking with local divers what sort of sea life you can expect. Some corals are painful to touch, some fish are poisonous. Learn what they look like. I can predict that the fish you meet won't be aggressive, not even the moray eel. I can predict only one thing about the shark, however, and that is that he's unpredictable.
2. Be suspicious of a headache in the water, and don't dive with one. A headache can be a good indicator of a bad air supply—also fatigue.
3. Don't dive if you are tired.
4. Cold-water diving requires fuel. Bring plenty of food along.
5. Never dive without a life vest.
6. Never dive alone.
7. Don't get the idea that merely reading an article like this qualifies you as a diver. You're not even ready for a shallow-pool dive yet.

Good diving. Good luck! PS

Among the extras a diver can add are a diving flag, a snorkel, spearguns, double tanks, mechanical propulsion, flash camera, float, and an underwater tow bar.

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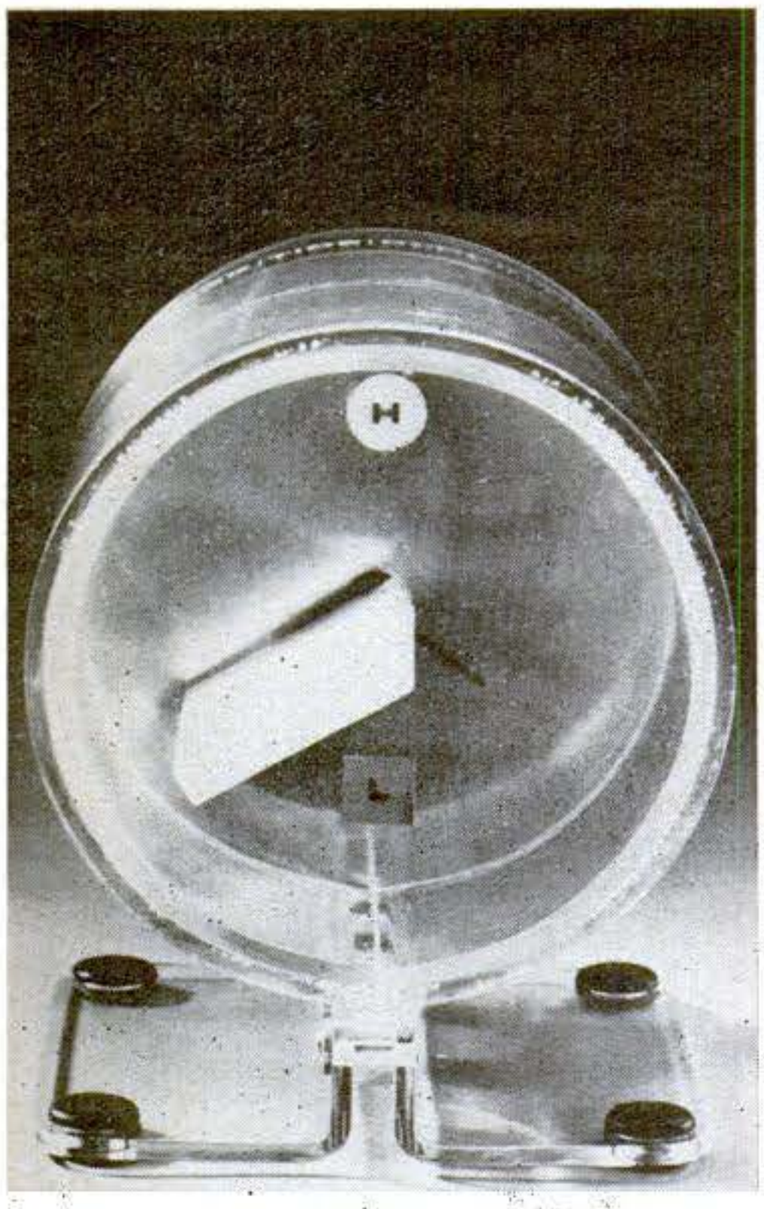
YOU CAN MAKE IT YOURSELF!

A Clock That Tells the Tides

By LEWIS A. HARLOW and HERBERT R. PFISTER



How to read clock. Here, tide-telling hand is nearing half tide, rising. Other hand indicates alarm will go off half hour or so before next low tide. If your watch shows 6 p.m. now, figure low tide tomorrow morning is about 10 hours away—around 4 a.m.

Most clocks tell the time. This one doesn't. Instead, it tells you the state of the ocean tides—something that old (and young) salts along the seashore are forever wanting to know.

You will find it easier and a lot more fun to consult this clock than the fine print in a tide table or a local newspaper listing. And think of the conversation it will generate! Your friends will all want to know what it is.

How it works. Inside is a windup clock mechanism that has been slowed down to lose 50 minutes every 24 hours. This loss puts it in phase with the tidal day, which averages out to 24 hours and 50 minutes long.

The clock's single hand (the original hour hand) makes two complete revolutions around its polished aluminum face each 24 hours and 50 minutes. Each 12 hours and 25 minutes this hand—a big piece of white plastic—comes around to the top of the face and indicates (naturally!) that the tide is high, or approximately so. Six hours and 12½ minutes later, the same hand indicates a low.

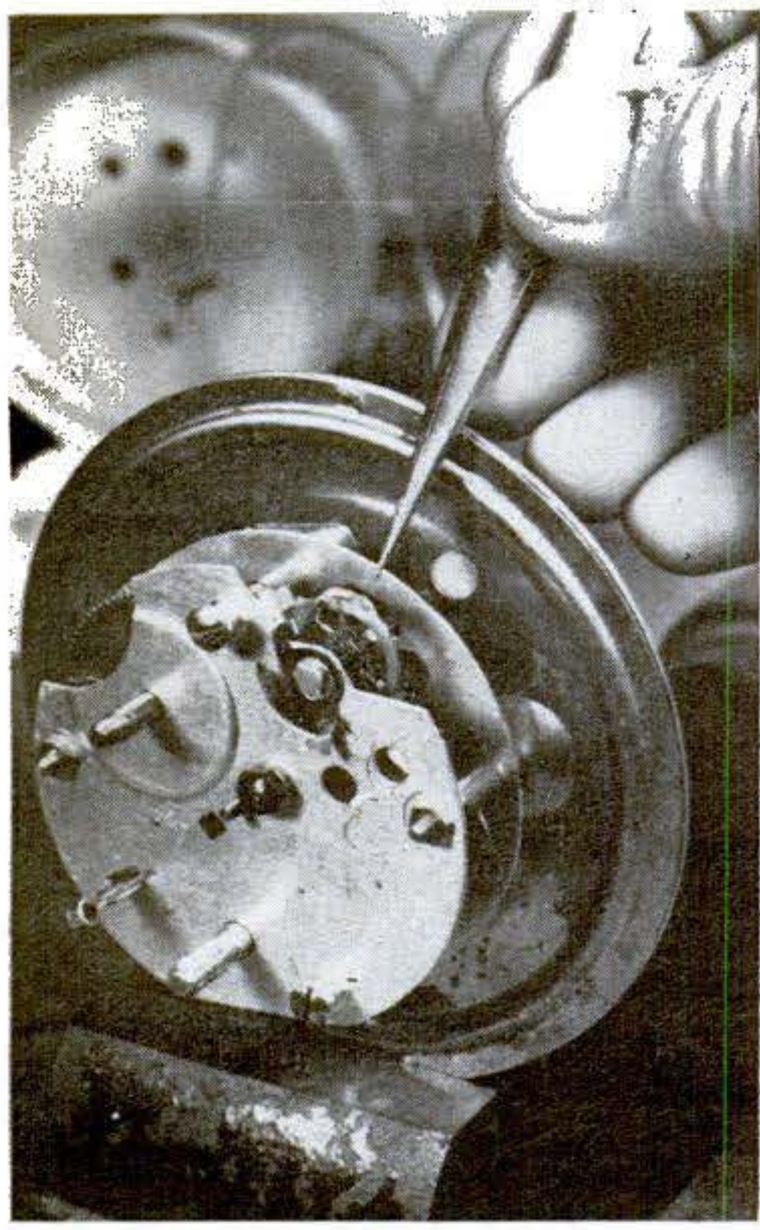
An additional hand, a conventional one, enables you to set the alarm if you want to awaken when the tide is at a particular stage—for instance if you'd like to go clamming tomorrow morning at low tide.

Is it accurate? Reasonably so. You will encounter the same inaccuracies that you may in reading published tide tables. For instance, strong onshore winds will bring very high tide at a later time, strong offshore winds will make low tide earlier. There also are seasonal variations of a half hour or more that such a clock can't keep up with.

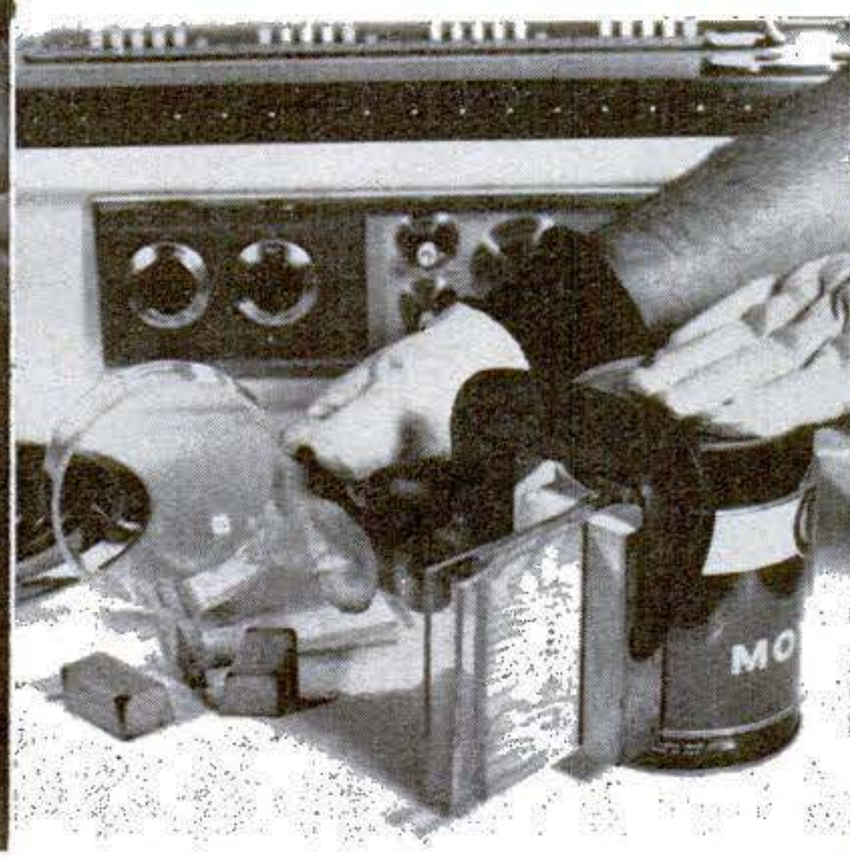
The clock will work only where tides are semidiurnal, that is, areas with two high and two low tides spaced over approximately 25 hours. This rules out use of the clock along parts of the Gulf of Mexico, in Hawaii, and occasionally in Alaska. After making the clock, you must set it to your local tides—and remember to keep it wound.

Slow down the works first. Choose any alarm clock with a face diameter of 4″ or less and you'll be able to fit it into the plastic case shown.

The case was designed by famous designer Ken Isaacs, whose far-out



Cement small piece of paper clip to the balance wheel to slow the clockworks until clock is losing exactly 50 minutes every 24 hours. When you get close to this figure with weight, a dab of cement or adjusting regulator will put it right on the nose.



Clock case is formed from strip of clear plastic heated enough to bend around a one-quart oil can. Wood blocks screwed to the plastic are key to a smooth bend. Insert a ¼″ plywood spacer as shown to establish spacing between the base halves.

Feet tabs are bent outward by pressing the reheated case down on a smooth oven top or counter. While keeping the feet flat on a piece of plywood, you can swing the round case to one side or the other so that the entire assembly becomes symmetrical.

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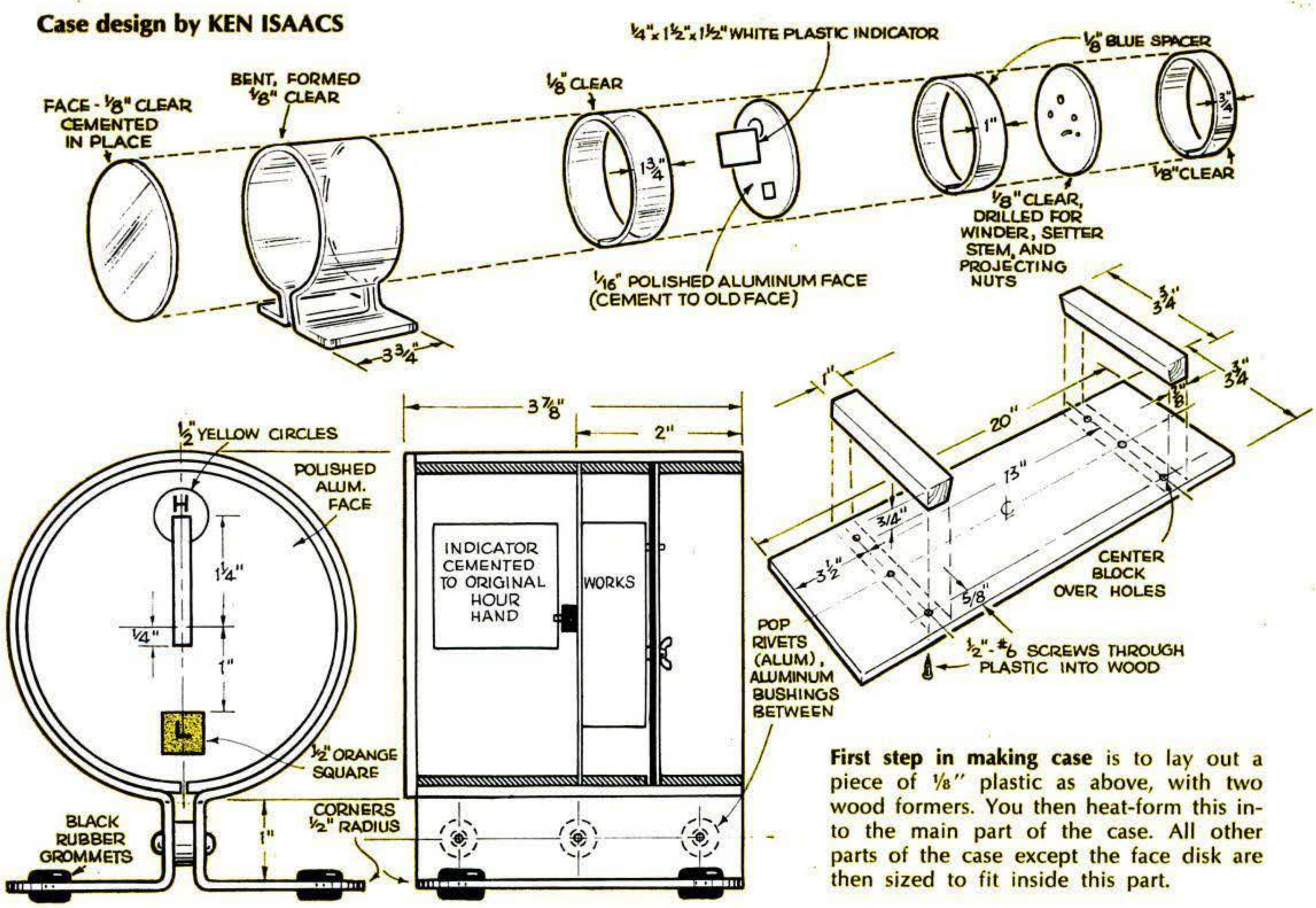
Case design by KEN ISAACS



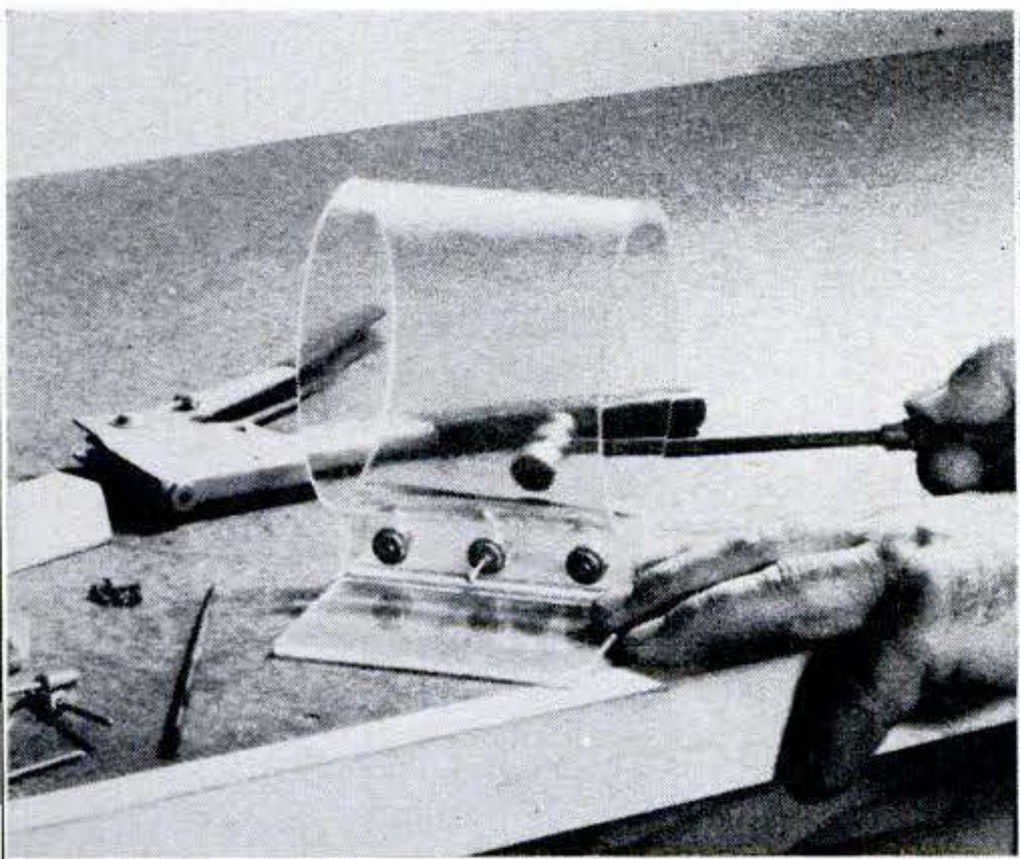
First step in making case is to lay out a piece of 1/8" plastic as above, with two wood formers. You then heat-form this into the main part of the case. All other parts of the case except the face disk are then sized to fit inside this part.

sunbathing bowl you'll find elsewhere in this issue.

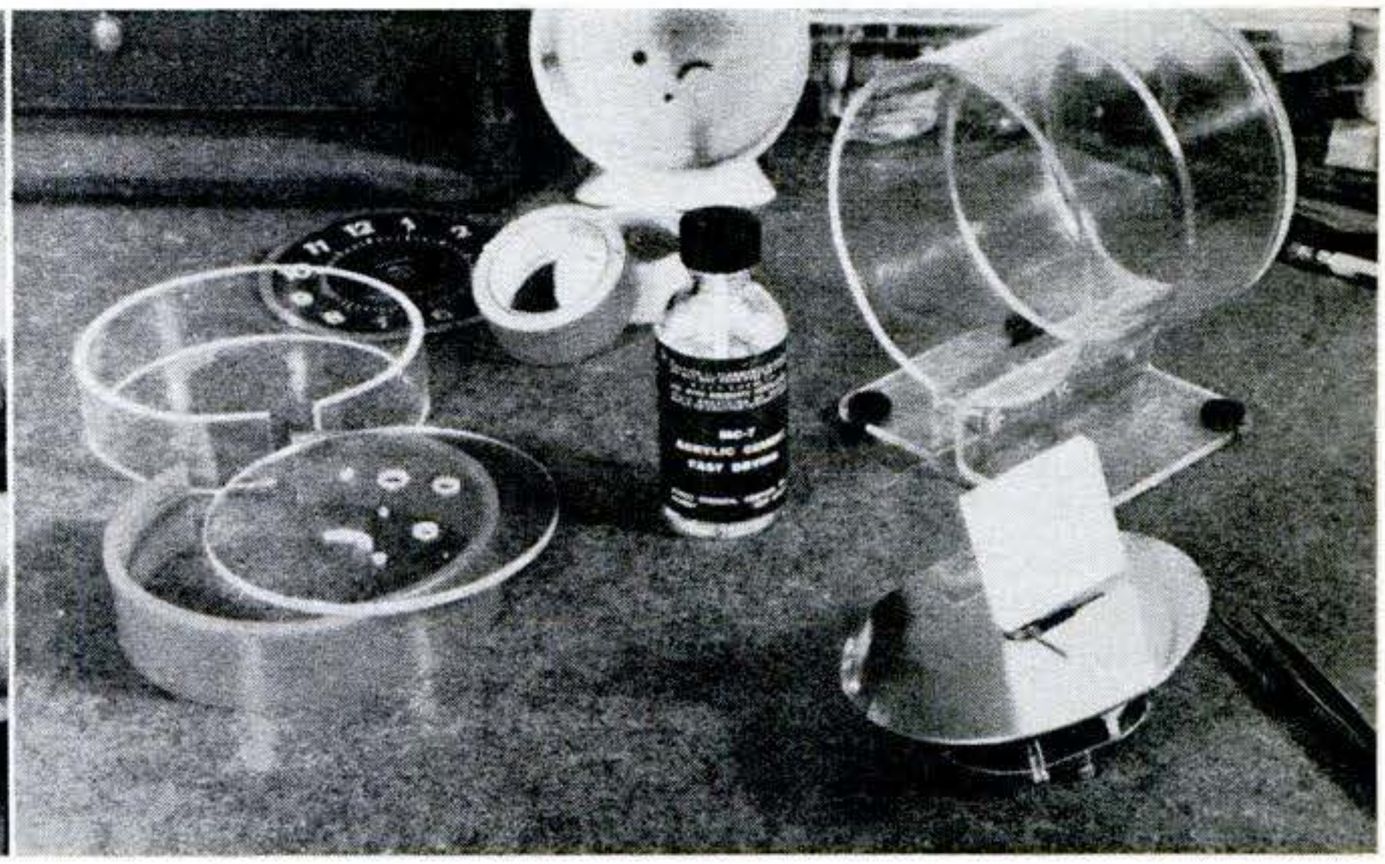
Remove the works, leaving the face and hour and minute hands intact. With the clock fully wound, locate the balance wheel oscillating back and forth. Set the fast-slow regulator at midpoint, then gently stop the balance wheel by pressing a strip of masking tape against it and the clockworks body. Snip a piece 1/16" long from a wire paper clip and cement it to the edge of the balance wheel in line with the pin that nudges the escapement pallets back and forth. This is the center of the balance wheel's oscillating swing. The extra weight will slow its movement in both directions.

When the cement dries, stand the clockworks vertically or put it in the clock case and let it run for a full day. When other clocks have run 24 hours and 50 minutes, the tide-clock mechanism must indicate precisely 24 hours. If it shows only slightly more than 24 hours, put an extra drop of

[Continued on page 142]



To keep the spacing between the base halves, you insert 1/4" lengths of aluminum rod (drilled) or suitable tubing. Align these bushings with the 1/8" holes drilled earlier for the two wood blocks, and squeeze Pop Riveter just enough for head of rivet pin to set rivet. Then tap pin out, leaving a neat eyelet type of rivet.



All elements of completed clock are spread out, above, ready for assembly. The polished aluminum face is cut from a cookie tray. Cement it over the original face. Press the alarm hand and hour hand back on the shaft and cement the square of white plastic to the hour hand. Cement high and low tide markers to the aluminum face. The words "tide clock" that you see on completed clock are negative photostat of line of type set by typographer.

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[Continued from page 59]

trailer is involved, I have recommended sintered linings, such as Raybestos or GreyRock. They hold up on race cars, and are certainly best against brake fade.

Some of you have disk brakes all around. Others have disks in front, with drums in back. You are the ones who write mostly about squeals and groans. If disk brakes squeal, it is no sign they're ready to go to the infirmary, so long as they function right. Certain noises are brought on by road dirt and moisture. Disk brakes hang out in the dirt and rain and snow, and the lining area is smaller.

But remember: if you hear unusual noises from your drum brakes, that *is* abnormal, and you should have it looked into without delay.

5 What causes my car to shake at high speeds, and why is there so much road noise?

When your car is trying to tell you about its aches and pains, it does so with a real gibberish. Bumps, thumps, groans, squeals, whines, moans, and rattles are some of its alarming but informative vocabulary.

You can look to the drive train as a source of a lot of these noises. This means all the driving parts from your flywheel, through clutch, transmission, and drive shaft to differential and rear axle.

All rear ends have a little noise in them, but sprayed-on sound-deadeners and floor mats moderate most. The limited-slip type are the noisiest, but if they are properly set up and lubricated to specs they are tolerable. Standard differentials are usually quieter.

Move on up to the drive shaft and you may find a major source of the shakes—if it isn't right. Bends, or even heavy deposits of road dirt or undercoating can throw it out of balance. So can worn universal joints at each end of the shaft.

Occasionally a clunking noise will develop from torque-lock—that is the shaft not sliding easily in and out at the back end of the transmission. It will sometimes free up as you add mileage.

Standard transmissions have noise and shifting problems occasionally. You can be pretty sure if you have noise or difficulty in shifting gears, the transmission is out of adjustment, or needs repairs.

Automatic transmissions, properly set up and maintained, are not very apt to give trouble. When they do, they should be gone over by an expert.

Wind noise is a problem in some car bodies—but it will have been there from the beginning. You can adjust windows and vents to minimize it. Vibration and noise are present with some air conditioners, but usually not on factory-installed models.

Many weird sounds can come from under the hood, but they mostly start from neglected lubrication or faulty drive belts.

6 My car needs new tires. What should I buy? Fiberglass, rayon, nylon; bias-belted or radials?

You won't get much help reading ads or manufacturing claims, for all sorts of claims and counterclaims are flying around. There is a tremendous fight in the industry between the rayon and fiberglass people. My vote is for glass right now. It gives you the most for your money although rayon cord gives a better ride.

No tire will give good mileage without proper maintenance. Getting the best tires that you are able to obtain, balancing them well, rotating every 5,000 miles, and checking inflation pressure are all essential. Make sure you don't overload, but drive with common sense, and keep correct alignment all around.

I cannot recommend the use of recaps, though if they are remolded right they can be fairly good. The best tire balancing is done on the car, because it balances brake drums, too.

The very best tires, in my opinion, are the radial tires with steel belts, as made in Europe by Michelin. They cost twice as much as some other types. So far as I can see, no American company has been able to match the European tire in cost and quality control. But I think B. F. Goodrich is not too far behind.

7 My engine pings when accelerating. The maker specifies regular fuel. Should I use premium?

The engineers who designed and built your engine spent months testing it, and what they recommend to burn in it will do most for your engine and pocketbook.

The main purpose of premium gas is to provide a full mixture that can stand more compression without self-igniting before the timed spark sets it off. Hi-test is a must in a high-compression engine, but used in a low-compression engine it is a waste of money and hurts the efficiency of your engine.

It's true that some engines will ping and rattle on the low-test fuel recommended, even though they are well tuned. The cause of this may be that the low-test you are using is too low for the particular engine in your car.

Some brands of gasoline feature variable-octane pumps. Starting with a low number, increase the rating on each tankful until the trouble stops. Then stick with that rating. If your engine pings and rattles on any fuel, either your engine has excessive carbon or it has some sort of combustion trouble that should be investigated further.

8 I see ads for various oil additives with claims that they clean and protect the engine. Do they work?

There is no magic in any additive can. If your engine is in good condition, and you are using the correct oil you don't need additives. Sometimes with some problems, such as sticky lifters, rings or valves, you can get some help chemically. To an extent you can chemically clean an engine and if it is worn badly you can sometimes get a little more life out of an old dog. Of course, when cleaning this way, you take the risk of damage from the loosened dirt. It is also possible to hydraulically seal some worn parts for awhile. Additives are good detectives, though. If your engine runs better with them, the need of repairs is obvious. Unless you use them knowledgeably, though, it is like taking laxatives for a headache, so far as relief is concerned. PS

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10 Most-Asked Questions

with answers from our owners' survey (See story on page 54)

1. What does a sauna do for you? The secret of dry heat's physical benefits is stepped-up circulation. The heat dilates your blood vessels, sending healthy, regenerative blood to all parts of your body. Profuse perspiration drains off acid wastes; it also deep-cleans the skin for a clear complexion. Tense muscles expand and relax, nerve endings are soothed. (Many athletes make the sauna part of their training program—often as a substitute for an active warmup *before* competition.) There's palliative relief from sinus congestion, rheumatism, and arthritis. And as a sleep-inducer, it beats any sedative.

One benefit every user I spoke to emphasized: Sauna-bathers don't catch colds. Whether it's all that fresh blood flooding to your head and throat to combat virus invasion, or the burn-off of disease bacteria (simulating Nature's healing fever)—the sauna seems to be worth a pound of cure.

2. Will it sweat off fat? Let's say it's better than a steam bath. Several people I interviewed claimed they'd lost excess pounds by careful control of liquid intake after sauna bathing. You certainly step out lighter than you went in.

3. How do you take a sauna bath? The consensus is that the most effective routine is: 1) A hot shower, lathering freely; rinse well, don't towel dry. 2) Enter preheated sauna and relax for five to 20 minutes. 3) Tepid shower without soap—or pool dip. 4) Second sauna session; some like to top it off by sprinkling water on the heater's tray of hot stones to create a steam. 5) Cool shower, increased to cold—or another brief swim. 6) Relax 15 or 20 minutes before dressing.

4. When, and how often? Some owners told me a sauna was a bracing way to start a day. Most, however, seek the solace of their saunas to unwind—either after a harried workday, or just before bed. Some claim it's a great "morning after" reviver. However, a San Mateo bachelor warned against sauna bathing the "night before." An airline pilot, he'd belted a few to calm ragged nerves after a foggy Frisco landing, then hopped in his sauna for further relaxation. Result: instant drunk. The stepped-up circulation sent the alcohol coursing through his bloodstream, and he passed out—very fast.

There are relatively few hazards connected with sauna bathing, though. It's not for people with high blood pressure or heart conditions. You should not, of course, smoke in the sauna—or exercise. Or use it directly after eating.

Daily bathing may become your way of life, but it's best to start with one to three sauna baths a week—at the highest temperature you find comfortable. All the owners assured me that one's tolerance for greater frequency at higher temperatures increases with experience.

5. How are saunas installed? It's an ideal do-it-yourself project, and over half the owners I interviewed had erected their own—indoors or out. You can buy complete room kits that assemble in minutes; or start from scratch, ordering only the heater and controls. Sauna walls are usually framed with 2-by-4s, 16" centers, with 3"-thick fiberglass batt insulation between the studs, the foil side toward—but not touching—the interior paneling. In the ceiling (which is usually 7' high), 5½" of insulation and a vapor barrier are best.

Two of the major California companies I contacted—Vico and Viking—offer a custom design service to anyone ordering their equipment.

6. Must inner walls be redwood? As we've noted, one company recommends other facings, and will even tell you that unfinished redwood blackens when exposed to steam. All of the *dry*-heat rooms I inspected—some of them four years old—were redwood-lined. None of this wood was seriously discolored. Redwood stands up to heat well and doesn't become too hot to touch. But if you plan to keep your sauna steamy, use another liner.

7. Must the heater be electric? Most are—of the gravity convection-flow type, with no fan. And most are imported from Sweden or Finland (though Vico makes its own.) The smaller ones (1,800 watts) can plug right into a wall outlet; but for a lie-down sauna room you'll want a heater that requires a 220-volt line. Don't worry about the electric bill. Owners of big saunas assured me that heavy use rarely added over $5 a month.

When I returned from the West, I discovered an interesting heater development in my own backyard. A contractor who'd equipped an all-electric private home in Clifton, N.J. had installed two radiant Glassheat panels in the basement sauna—instead of a stove. These are tempered glass fused with aluminum heating elements, and look like giant Salton hot trays. They take no space, and heat you by means of infrared rays, as sunshine does. The bath I took in this sauna at 168 degrees compared favorably with ones at higher temperatures from conventional heaters. Heat-up time was slow.

Purists will protest that this is not a true sauna, since it omits humidity control. But infrared heat may provide bonus health benefits over convection (air-flow) heat.

There are also gas heaters, at about the same price for a given capacity—though often cheaper than electric ones to install and operate.

8. How do people get hooked on saunas? I gathered many answers—from the German lady in Los Angeles who told me she first tried one in the nudist camp back home, to the fireman in South San Francisco who equipped his new house with a big sauna because he'd enjoyed the one in the mobile park he moved from. Most owners, however, were introduced to saunas at a health club or motel.

San Francisco pool owners told me their saunas extended the swim season. In middle-latitude climates, taking a sauna before you dive in lets you use an unheated pool all year. You just don't feel the cold.

9. Should there be steam? That's the major controversy. Many people think a Finnish sauna *is* a dry heat bath, as distinguished from the soggy Turkish type. Yet, Finns often ladle water over the hot stones.

Vico proudly points out that their heaters have leakproof rock trays and are insulated against moisture. They encourage their customers to splash water on the rocks. I find the effect stifling, but it's a matter of taste. No sauna, then, is for everyone.

10. AND WHAT DO SAUNAS COST?

Viking Sauna Co., P.O. Box 6298, San Jose, Calif. 95150, offers five electric heaters ranging from the BTK-4 (175 cu. ft. max.) at $495 to the BTK-12 (825 cu. ft.) at $805. Control panels range from $50 to $209. Solo Sauna (shown on page 56) is $495 for door alone or $695 for complete 3'-by-3' room. Larger prebuilt rooms start at $1,495.

Vico Products Mfg., Inc., 1808 Potrero Ave., South El Monte, Calif. 91733, offers their largest Ultra-Sauna heater in gas or electric versions—40,000 BTU or 9,000 watt—for $720 (including control panel). Smaller electric heaters come in the following wattages: 1,800 (4'-by-4' room max.) or 3,000 (4'-by-5') $350, 6,000 (6'-by-7') $500. Prefab rooms in aluminum range from $975 for a 4'-by-4' to $1,675 for a 5'-by-8'. In stainless steel, from $1,415 for a 4'-by-4' to $5,235 for an 8'-by-8'. Also wooden prefabs in various sizes: from $600.

Continental Radiant Glass Heating Corp., 437 Fifth Ave, New York, N.Y. 10016 makes the 1,500-watt panels used in the stoveless sauna. They're available through local distributors at a suggested list price of $122.75 each. The sauna application was developed for Continental by D. F. Curtin, Infrared Electric Heating Co., 465 William St., East Orange, N.J. 07017, who will make installation recommendations to interested PS readers. PS

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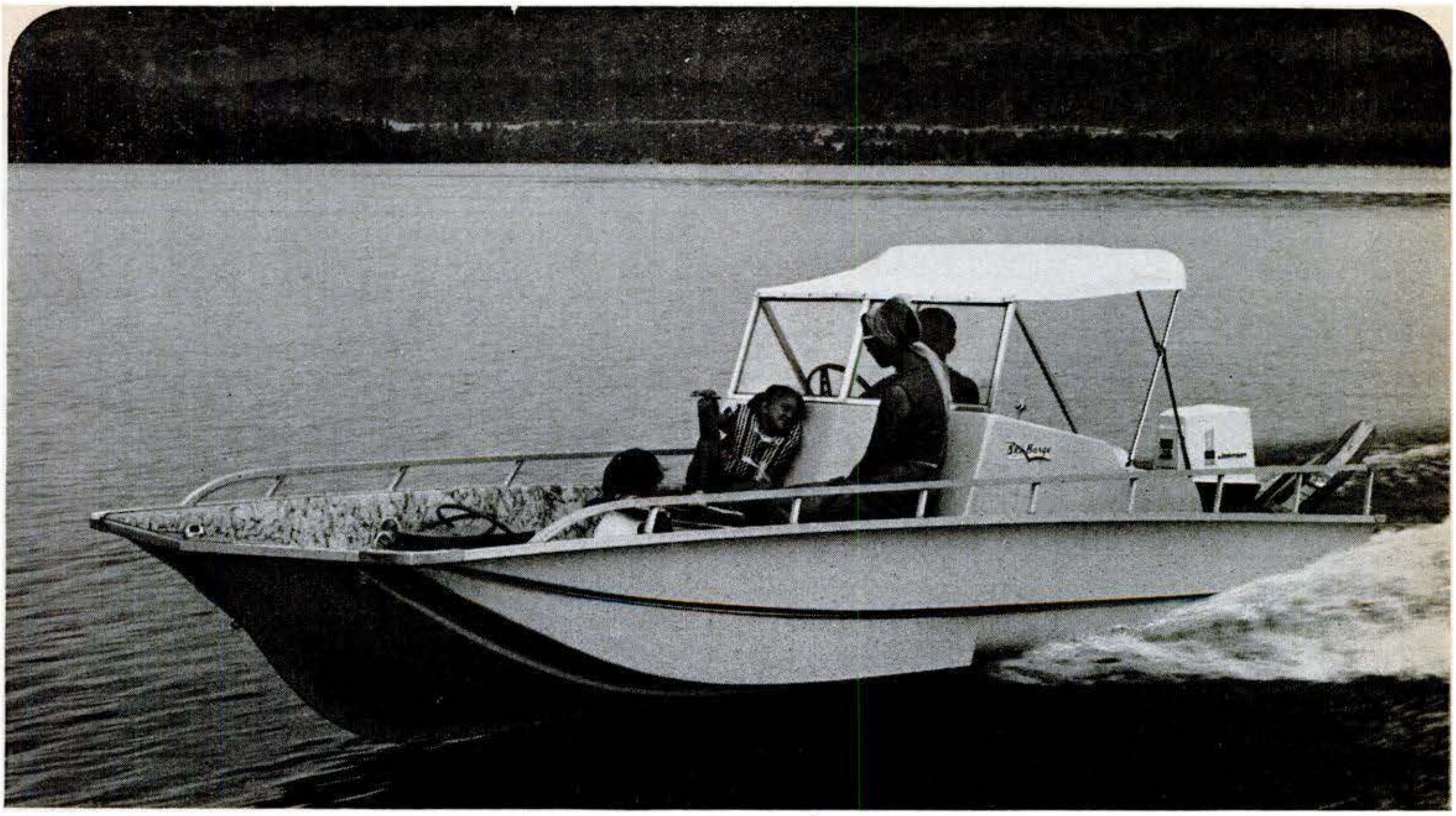

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What Fun Boating People Have

[Continued from page 79]

boating skills and to share in the tremendous fun of it.

You might like to join a specialized group like the hotshot water skiers or full-time fishermen, but most boating communities have at least one robust club where just owning and enjoying a boat is the ticket.

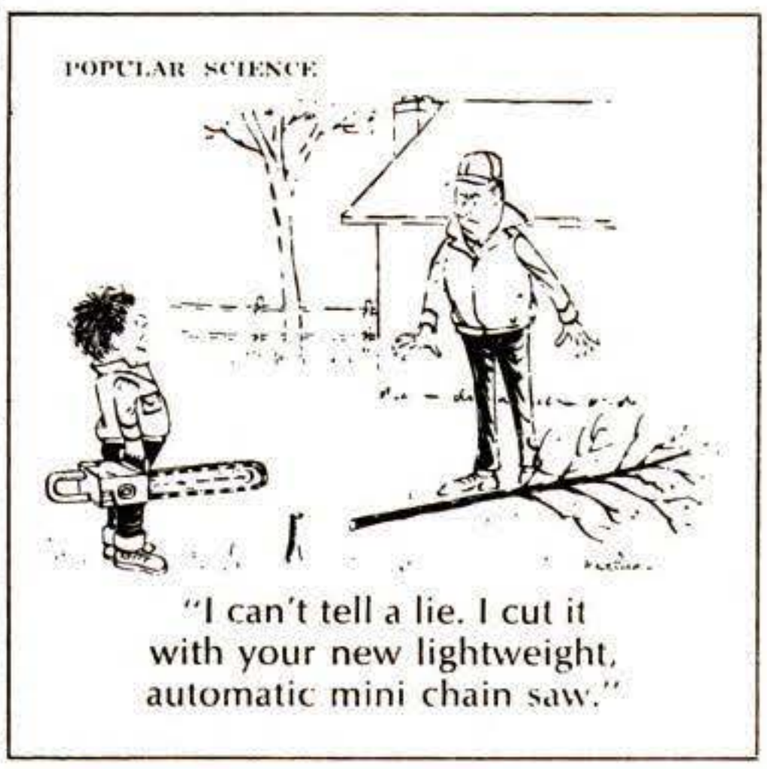
Starting a club. An organization of boating clubs that has grown like wildfire in the last few years is the Outboard Boating Club of America. Supported by the boat industry as well as by local affiliates, the OBC can help new clubs get started and established ones to complete their projects.

The Savanna (Ill.) Boat Club has become famous as the host of the annual Mississippi River Days cruise. Boating families from all over the Middle West trail their boats to join in an overnight cruise some 50 miles upriver in excellent boating territory to beach their boats on sandbars for the night. One year, the flotilla of 218 boats with about 750 people aboard was joined by enthusiastic onlookers at Dubuque, until there were 300 boats and 1,000 people in the party! But that was the largest on record.

Each club has its own particular focus. Some go in for community service—safe-boating demonstrations, civil defense work, Boy Scout exercises, conservation. The San Leandro (Calif.) Boat Club is an active member of the Save San Francisco Bay Committee, which means to save the bay from pollution and harmful construction. Its members, continually on this water, are in position to observe abuses and make vital suggestions.

Lack of dock and clubroom facilities is no reason to delay formation of a local club if your community needs one. The Evansville (Ind.) OBC has the Ohio River for its meeting place and has been considering use of a big river barge to serve as their clubhouse base.

Organized or unorganized, boaters just do have a lot of fun. PS



"I can't tell a lie. I cut it with your new lightweight, automatic mini chain saw."

A Clock That Tells the Tides

[Continued from page 137]

cement on the piece of paper clip to add a bit more weight. If it shows much more, cement another small piece of paperclip alongside the first. Should the clock show less than 24 hours, remove the original piece of paper clip and cement a smaller piece in its place. When you get the clock losing only a few minutes more or less than 50 minutes, try a fine adjustment with the "fast-slow" regulator.

Making the case. While the clock is being adjusted, you can begin work on the new housing. Cut a strip of 1/8" clear plastic 3 3/4" wide by 20" long. Drill three 1/8" holes 3 1/2" in from each end as shown in the drawing, and screw two 3 3/4"-long tapered wood blocks to the plastic.

With a pair of C-clamps and a clean, undented one-quart oil can at hand (juice, coffee, and other food cans are not suitable because their sides are ribbed), heat the plastic until it's soft and pliable. We did this in a kitchen oven set for 400 degrees—which involves certain risks. The Plexiglas people caution that their material should only be heated in air-circulating ovens. Since home ovens aren't of this type there's some danger of the stuff melting onto the coils and flashing into flame. But if you watch it carefully it will be safe. Use cotton gloves to protect your hands from the heat and the plastic from finger marks as you wrap it around the oil can. Insert a 1/4"-thick separator between the meeting ends, and tighten the C-clamps on the blocks.

That's a lot to do in the short time the plastic stays pliable, but if you don't get it right the first time (or the second or third), reheat the plastic. When this first bend is completed successfully, with the meeting ends aligned and clamped, put the whole thing—plastic, oil can, and clamps—back in the oven (or in front of the heat lamp). When pliable again, remove it and bend the protruding ends outward to form the base. Press it flat on the oven top or counter, using a 4" square of plywood to hold the base flat while you force the housing to the left or right to center it over the base.

Completing the base. Spread the base apart and remove the screws holding the wood blocks. Cut three 1/4" lengths of aluminum rod, drill 1/8" holes through their centers, smooth the cut ends by rubbing them first on a flat file, then on fine sandpaper and very fine (600-grit) emery paper. Finally, polish them with steel wool.

Slip the aluminum bushings into the 1/4" space in the base, align them with the 1/8" holes drilled earlier for the wood blocks, and push "pop" riv-

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ets through the plastic and the bushings. Check to see that the base is flat on the bench top. If the rivets have forced the two base members out of alignment, remove the rivets and elongate the holes with a thin round file, cutting in the direction needed to restore alignment of the base. Insert the rivets again, place a washer on the end of the rivet, and pull up the pin with the riveting tool.

Look, it's an eyelet! When the rivet feels snug, remove the riveting tool and tap the pin out of the rivet, leaving a neat eyelet—not the way the manufacturer of the tool intended, but ideal in looks and holding power.

After riveting all three bushings to secure the base and to make the housing rigid, rub the ends of the housing across a sheet of 150-grit sandpaper, checking occasionally to see that both ends are square with the base. When smooth and flat, rub the ends across a sheet of 600-grit emery paper to polish them. Drill holes near each corner and install rubber grommets. These serve as feet.

Make a face. Cut a disk of 1/8" clear plastic slightly larger than the diameter of the housing, dip the edge of the housing in a flat dish wet with solvent, and press the disk firmly in place to seal the face end of the clock. File the overlapping edge of the disk carefully to bring it flush with the outer surface of the housing, sand smooth with progressively fine sandpaper, finish with 600-grit wet or dry paper, and buff the entire outer surface of the face and housing to remove finger marks.

Cut a 2" x 12½" strip of 1/8" clear plastic, heat and bend it around the same oil can used to form the housing. Sand the edges smooth and buff them to a clear polish, then trim the meeting ends until they meet lightly when the ring is pressed inside the housing and slide up against the case face.

By this time the clockworks should be adjusted to lose 50 minutes in 24 hours. Gently pry the hour hand, minute hand, and alarm hand off the clock shaft and set them aside. Cut a disk of aluminum from a small inexpensive cookie tray to fit easily into the housing. Drill a 1/4" hole in the center of the aluminum disk, carefully remove any burrs. File the edge smooth, and buff the disk to a high polish. Cement the disk over the clock face with epoxy or contact cement, taking care to center the hole around the hand shafts. Press the setting hand on its shaft, then install the hour hand.

While the epoxy dries, cut a disk of 1/8" clear plastic to fit inside the housing, mark and drill the disk for the holes for the winder, alarm set, and mounting screws, as well as the curved slot for the regulator. Cut a 1½" square of 1/4" white plastic and cement it to the hour hand.

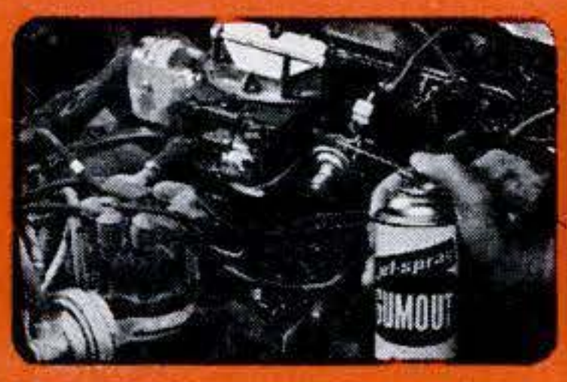
Assembly. Slide the clock into the housing, pressing it firmly against the ring of clear plastic installed earlier. Press the clear plastic disk against the back of the works and measure the space between it and the rear of the clock face. Cut a 12½" length of blue plastic to this width, heat bend, and polish it as you did the first ring. Trim the ends for a snug fit and slide it in.

Install the clock back plate using screws of the same thread but slightly longer to accommodate the extra thickness of the 1/8" plastic.

Make the last ring of clear plastic to come out flush with the rear of the housing and press it firmly against the back plate of the clock.

Set the clock to coincide with the tides listed in the weather section of your daily newspaper. This will give you fair accuracy for any subsequent day. If you want a more precise setting, watch for a day when the evening tide is exactly 12 hours and 25 minutes later than the morning tide. PS

All the glop gone–in 52 seconds!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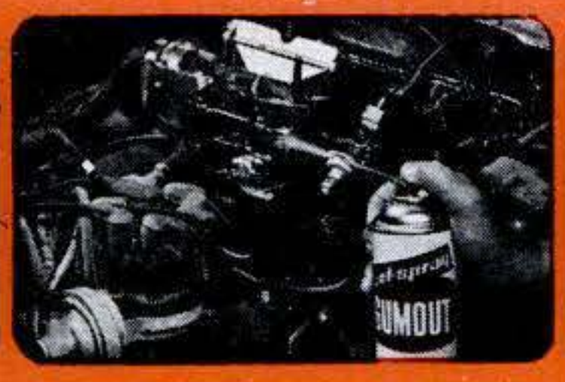
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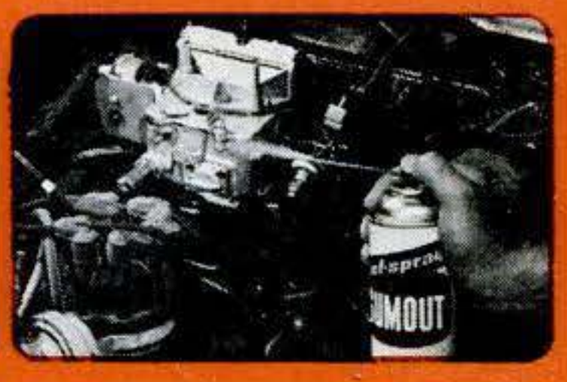
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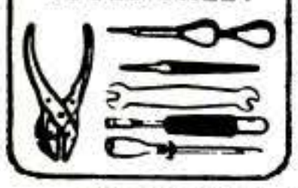

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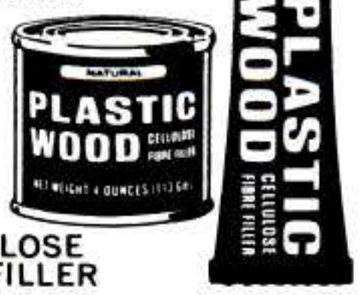

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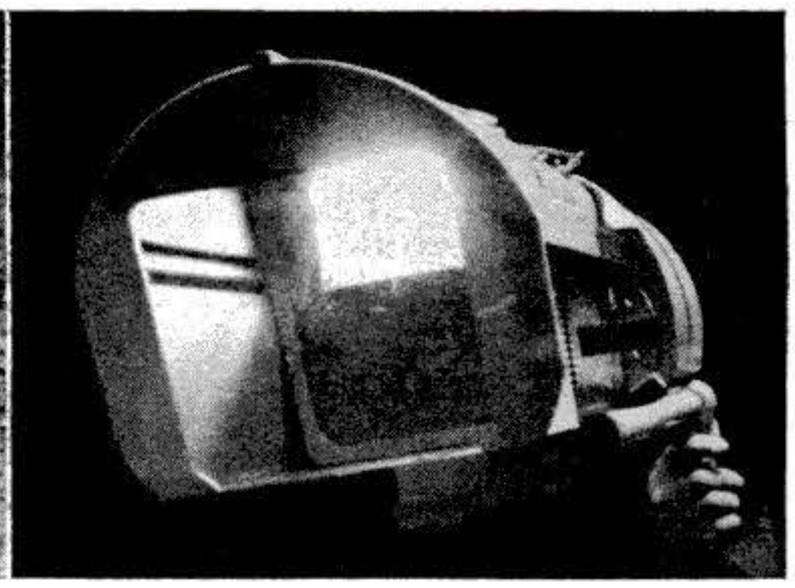
Surprising Facts We're Learning from the Moon Landings

[Continued from page 64]

Spangles resembling spilled solder, pictured above on lunar soil by the camera in view at right, have been called possibly a relic of a giant solar flare-up in the past.



"Walking-stick" camera, with built-in flash, was used by Apollos 11 and 12 to make extreme close-ups of lunar-soil details too fragile to bring back intact.

Toward that end, Apollo 11 moon rocks are being tested for luminescence under various kinds of radiation by Dr. Norman N. Greenman of Douglas Aircraft Corp., Santa Monica, Calif.

As prospectors know, some earthly minerals—like the tungsten ore scheelite and several uranium ores—fluoresce or glow in telltale colors under the "black light" of an ultraviolet lamp. Dr. Greenman already has shown that silicate minerals like the moon's can likewise be identified by their luminous response under X rays, protons, or ultraviolet light—all present in solar radiation striking the moon.

Once the fluorescent behavior of different lunar minerals is cataloged, a lunar-orbiting Apollo with remote sensors should be able to recognize and map these minerals anywhere on the moon. NASA is considering plans to equip an Apollo for that purpose—possibly in time for Apollo 16, the sixth lunar landing.

Moon instruments' surprises, Besides a laser reflector for earth-moon measurements, Apollo 11 left on the moon just one scientific lunar experiment—a solar-cell-powered "moonquake detector," or seismometer. In three weeks before it quit working, it transmitted puzzling reports. Experts found its squiggles hard to identify as meteoric impacts, landslides, or true quakes, because they were so unlike recordings on earth. Apollo 12, which set up a whole observatory of nuclear-powered instruments including a new seismometer, told why.

Key to the mystery was the Lunar Module ascent-stage crash, which provided an artificial impact of known magnitude. When the lunar tremors lasted 55 minutes, amazed observers saw that, to understand them, they would have to "throw the book away." Wild guesses were made and discarded before a reasonably likely explanation was tentatively proposed as to why the moon rang like a bell:

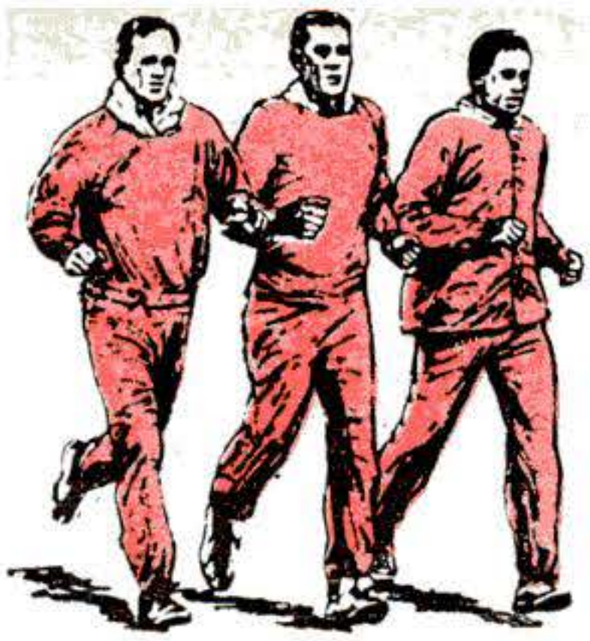
Echoes. The tremors, it was theorized, reverberated in a natural underground "echo chamber" of gravel and rocks, sandwiched between a roof and floor of lava beds. In such a formation on earth, liquids or gases in the interstices quickly "damp out" vibrations—but on the moon the voids are vacuums and the reverberations go on and on. Whether this theory ultimately prevails or is replaced by another, this much now seems to have been made clear.

From the prolonged after-effects of the ascent-stage crash, it's now concluded that the squiggles of Apollo 11's seismometer, spanning periods up to six or seven minutes, represented natural meteoric impacts; it no longer seems incredible, as it had before, that such tremors could go on so long. Apparently this instrument detected no true "moonquakes" at all. Whether the new one will do so remains to be seen; if not, evidence for a non-volcanic "cold moon" will be strengthened.

Apollo 12's lunar observatory already has furnished other surprises. Only after tests to make sure a magnetometer hadn't gone haywire did earth observers believe its readings. It showed a lunar-surface magnetic field of 30 gammas—only 1/1,000 of what swings a compass needle on earth, but five to 20 times what was expected on the moon.

This and other evidence will ultimately help tell what the moon's interior is like. Other instruments will detect any lunar atmosphere and ionosphere, and study "solar wind."

From the surprises of Apollo 11 and 12, one of the two outstanding conclusions is that we still have a lot to learn about the moon! The other is that what we do learn should be more intriguing than anyone, before the landings, had dared hope. PS



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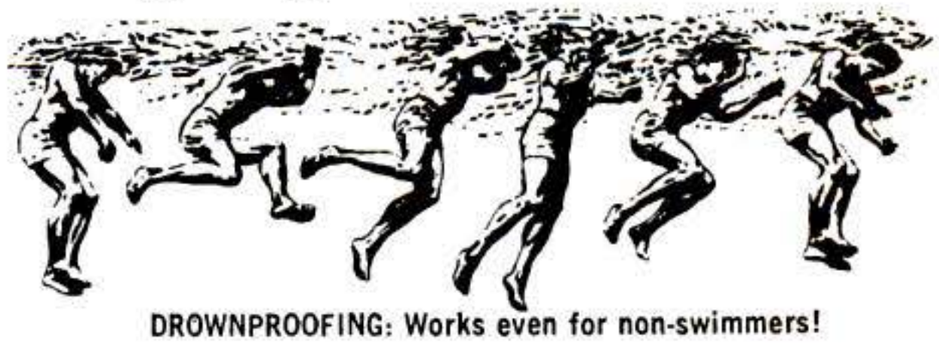

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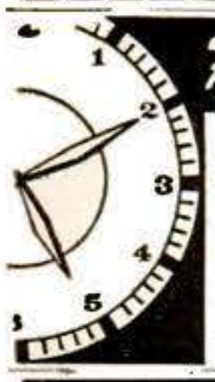

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Multiplying Sound with a Tape Recorder

[Continued from page 102]

Since you have three performers, each of whom is going to do four different parts, you record your piece three parts at a time.

You must record at the highest level consistent with negligible distortion, because on every pass the machine adds a little tape and machine noise. Unless noise is kept well below the program level, you may run out of signal-to-noise ratio, and get an objectionable amount of hiss by the third or fourth pass.

It takes five passes to multiply the three of you by four. You can go to higher numbers if noise doesn't become a problem. You could do one part at a time. One person who can play three or more different instruments can build music into a great concord of sound.

Make it stereo. In the procedure described, you end with a mono recording—the same thing in both channels. To get some stereo, with some parts on the left, some right, and some middle, use only the first two passes, plus a balancing pass, to put six parts in both channels. Then divide the remaining six parts into two groups, one for the right channel and one for the left. (You might reserve the lead voice part for the left channel.) Put them in their respective channels, using sound on sound, in two more passes.

If you have followed through the examples, you realize that there are a bagful of combinations and permutations of the three multisound techniques. Here is a sampling:

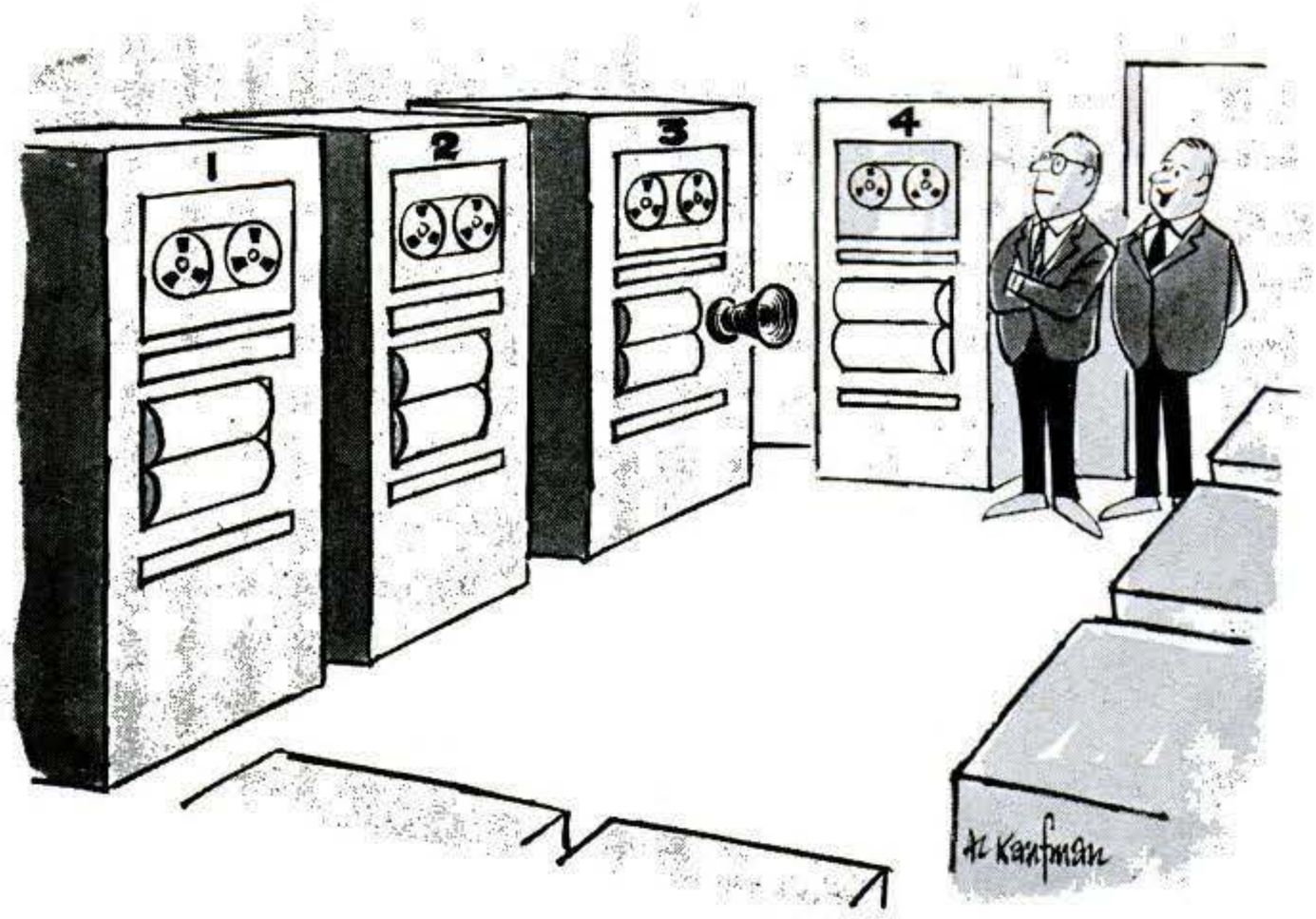
Ultra-rapid language study. You can get a good accent in any language in an astonishingly short time using sound with sound. A teacher or model (live or recorded) speaks onto the left channel words or phrases for you to imitate, leaving tape space between each for your imitation. You listen to the tape, repeating each word or phrase immediately after you hear it, and recording that on the right channel. When you play the tape, your errors are super-apparent in a way they can never be if you listen simply to your own speech.

You run through again, trying to correct your errors, your new attempts erasing the old. (Keep the left channel in play always to avoid erasing the teacher). Playing back the second attempts, you can spot where you made progress and where you did not. You can do another repeat, then or later, until you sound like a native.

This trial-and-repeat is highly effective for improving diction or public-speaking style. You can use it for music phrasing, too, recording as models phrases from recordings of performers you admire.

Impossible combinations. And amusing confrontations, too. Here belongs the duet with Artur Rubinstein. Sound with sound can join the unlikely or impossible. One of the strange partners comes from a recording (you need a record player that can be plugged into your tape recorder). The other can be live or recorded; but you may be unable to synchronize two recordings if the material demands exact timing, like duets. That is better

POPULAR SCIENCE



"Number three laughs at my jokes."

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done with a recording plus a live performer who can adjust the timing.

A few suggestive wild shots: far-out music, perhaps a bit of Brahms with *The Jefferson Airplane* (the less synchronization on this, the more amazing); acid running commentary for political speeches; sound effects for comedy; your own additions to recorded plays; very audible conducting ("now—now—hit it men!") for orchestral recordings; sing-alongs, with every variety of lyric, added to serious or pop music. A little imagination will extend the list. And don't forget that impossible combinations need not stop with two items; sound over sound can add more layers.

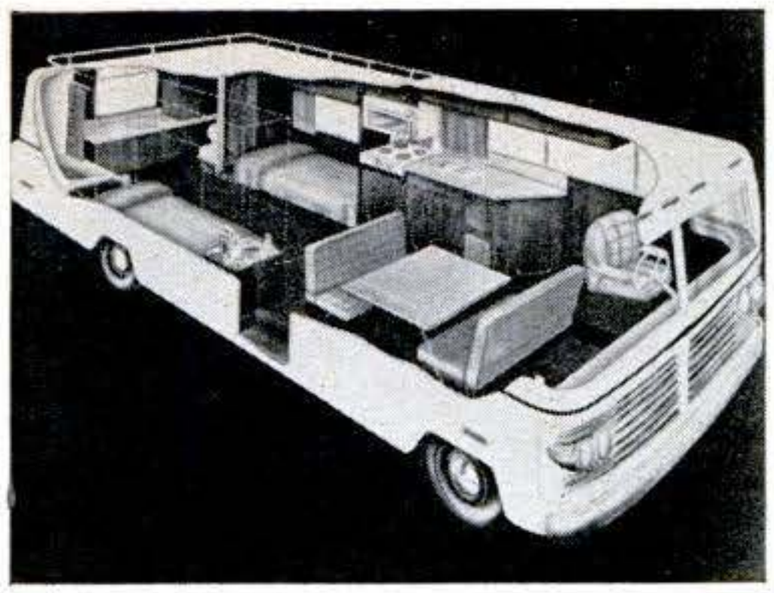
Home-movie sound tracks. Sound for home movies today usually comes on a magnetic track on the edge of the film, with recording done on the projector, after the film is edited. Many of the better with-sound projectors have one multisound technique built in: sound-on-sound, used mainly to put a narrative voice over musical background. But many other possibilities open up if you make the sound track first on your tape recorder, then dub it onto the film.

Multisound lets you work in different layers of background material: sound effects added to music, etc. Or on-the-spot recordings, made with a small portable tape machine, can go onto the master tape.

You can time background changes closely enough by timing your edited film with a stopwatch, leaving a little silence or neutral music at the breaks so split-second synchronization is not needed. But you can't dub dialogue from the tape recorder over onto the film, if the actors who speak are seen. That takes "lip sync", which professionals use elaborate equipment to get. Amateurs must put all the sound on the film strip, except the dialogue. Then the actors repeat their words, while watching themselves on screen, and that is recorded by the "voice over" feature on the projector.

Narrative for memory tapes: Recordings of weddings, great sports events, meetings, etc., can be made into more interesting "productions" by adding descriptive voice later. Voice can be interspersed with the original sound by tape editing.

Music composition. The composer can hear his work coming at him, instead of going away from him, over and over at will. That brings sharpened perception, in much the same way that it does in language study. If he is competent on a few instruments he can hear his ensemble effects without hiring an orchestra to play for him. PS



Avco motor home—a new spacious breed.

Luxury touches also grace the '70 Coleman CT 490. It even has a choice of cranking speeds for raising the top of the rig—fast-raise for men and slow-raise for women or the elderly. The sidewalls are also permanently attached to the top, so it's practically erected by the time you finish raising it.

A whole new fleet of land yachts graced the Louisville showplace, too. Besides the well-known Travoco and Winnebago brands, there were some notable newcomers and other competitors. These included Explorer, Open Road, Islander, Landau, Lifetime, Kayot, Avco, Fan, Starcraft, Glastron, Executive, Banner, and Barth.

Most of these rigs use the Dodge truck chassis and 318-cu.-in. engine. But several either use the Chevrolet chassis and 350-cu.-in. engine exclusively, or offer it as an option.

The show also exhibited many new models of pickup campers, chassis mounts, and travel trailers stressing more comfort than ever before.

One of the newest entries in the travel trailer field is Del-Rey, which introduced Casa Del Rey trailers—18- and 22-footers. The interiors are slicked up with luxury extras and rich paneling and upholstery.

Scouting the show, it looked to me as if all these new rigs would propel camper sales to their best season yet, and provide you with a great choice when you get set to buy the one that was built just for you. PS

Winnebago Chieftain sleeps six inside.

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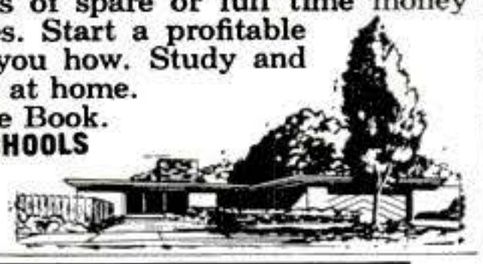

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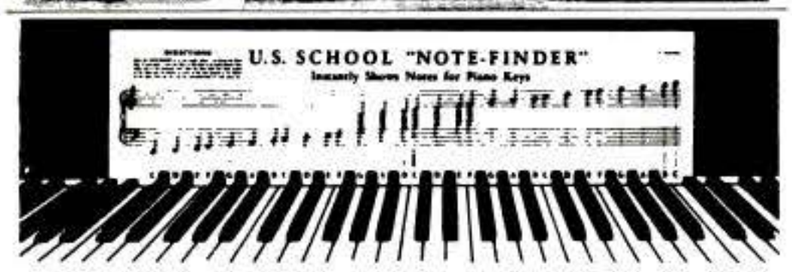

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The Case of the Agile ATVs

[Continued from page 73]

that come down to touch the ground.

I had bulldozed a way up onto one of the hills so that we could get up with a tractor. We made a picnic place where the ATVs could scoot up a steep hill with no effort whatever.

We carried in great tubs of cracked ice, filled with beer and soft drinks. Lining up two of the ATVs, we put boards across them to make an impromptu table and consumed huge quantities of ham, canned tongue, beans, sandwiches, homemade cookies, sweet pickles, olives, potato salad, hot coffee, and drinks that were ice-cold.

Bruce Barron entertained us at lunch with music, playing simultaneously on the guitar and the harmonica.

Following lunch we went up to huge Vail Lake, its waters well stocked with fish and impounded behind a high dam, on the Rancho California.

Taking to water. Only three of the ATVs were amphibious, and two of these machines depended on rotation of the wheels to propel them through the water. This gave them a very slow speed, about that of a swimming horse. But it was something to see these machines plunge down into mud and muck along the banks and out into the water.

The Coot had a propeller and a rudder which made it much more maneuverable in the water.

I would say that the use of ATVs as boats should be limited to stretches of calm water where the machines can be kept relatively close to the shoreline. Should a strong wind come up, I believe these vehicles would be tough to steer, and I don't think they have anywhere near enough freeboard to withstand what I would consider even a moderate wave in a wind.

But for running along the banks, getting out into the shallows, locating choice fishing grounds, and furnishing a deluxe place to sit and fish, these vehicles are ideal. And they're great for reaching duck blinds.

If you want fun, ATVs can give it to you in a way that you can't get otherwise. It is fun just driving them, getting into odd corners where other vehicles can't go. And, because you have this means of transportation available, you begin to look up places to explore and photograph that you wouldn't bother with otherwise.

These are rigs that make for free-and-easy informality in areas far from smog, crowds, and traffic.

And in this period of mounting tensions any opportunity to just relax and enjoy good old-fashioned fun is an enormous boost to your health and an experience to be long remembered. PS

Come Drive Mercedes' Wunderwagen

[Continued from page 87]

you feel a certain jerkiness in the steering wheel. Keep going. Here's a turn, a pretty fast one. Downshift to fourth, then third, as you brake with your right toe and dab at the throttle with your right heel. Around the apex? Yes, yes. Accelerate hard, get back up to 140 or so. Wow! What a machine, man.

How did they do it? The Wankel engine is only part of the answer. Most of the rest lies in the chassis design, and some of it even in the body.

Mercedes-Benz can modify the handling characteristics of a racing car by making small adjustments in the suspension system to meet the exact requirements of a certain track and a certain driver. I was able to drive two C-111s in a demonstration of how much difference a slight change can make. Both cars had the same power train, but one had Dunlop racing tires, the other Michelin XVR radials. Both had nine-degree caster on the front wheels, making steering a bit hard but giving strong self-centering action.

I liked the car with the radials better, for its softer ride and reduced jumpiness on ripply roads. But the point is that the C-111 can be made to handle in the best possible way for any set of conditions.

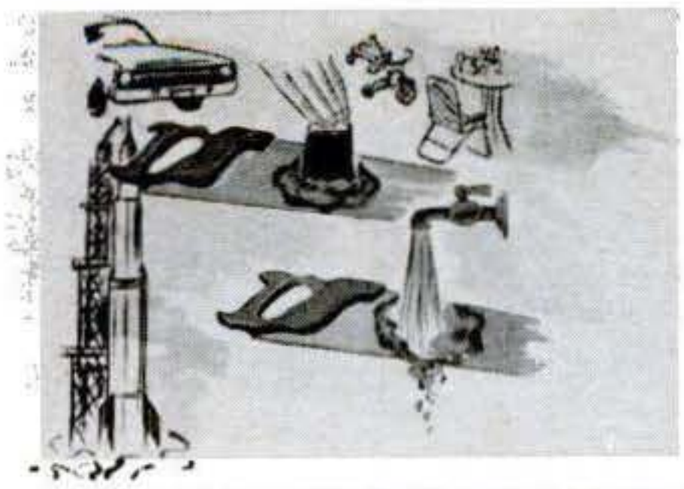
The brakes are, of course, four-wheel disks. The front suspension has strong anti-drive; the rear suspension some anti-squat. These brakes are immensely powerful, and will haul the 2,500-pound car down from 125 to 50 mph in about three seconds and less distance than you'd believe.

Another important thing. The body was wind-tunnel-developed for low drag. But Mercedes-Benz also satisfied themselves that the car was fully resistant to crosswinds, even at its top speed of about 165 mph. Static-weight distribution is about 45 percent front, 55 percent rear. At 150 mph there is a 33-pound aerodynamic lift force on the rear, but the nose benefits from a 66-pound negative-lift force that keeps it on the ground.

As you get used to throwing this Wunderwagen around the race track, you notice it doesn't have much torque below 5,000 rpm. But at 7,800, if you insist on keeping a lower gear, the fuel-injection pump stops delivery, and revs fall smoothly till you're back within the permitted range.

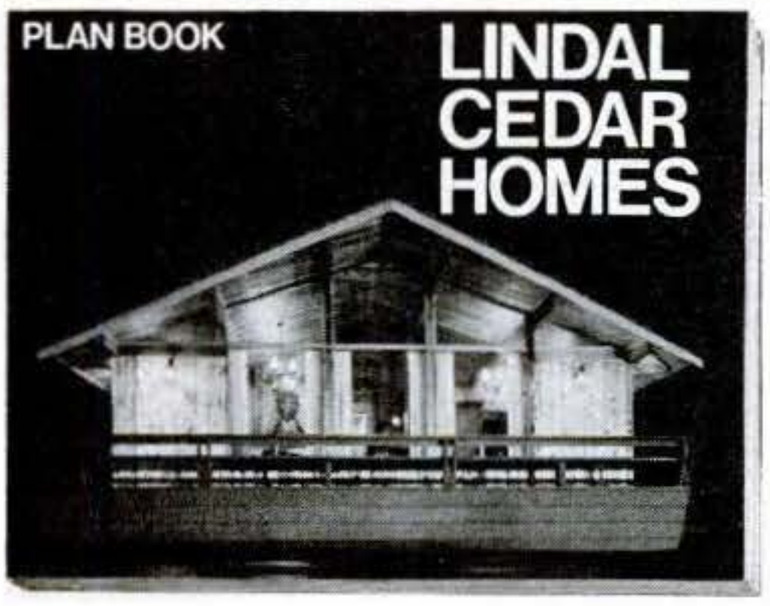
If anybody had set out to make a deluxe racing car, this would be it. We didn't make any timed straight-line acceleration runs, but the factory says it will move from standstill to 60 mph in just under five seconds. That's pretty good for a small car with an oversize lawnmower motor. PS

SHOPPERS' SHOWCASE



NO MORE RUST! "Rust-off" Gel dissolves rust on any surface without wire brushing, sandblasting or scraping. Just brush on, wait, then wash off. Fumeless, non-flammable, easy to use. Not affected by temperature. Prevents reoccurrence of rust. ½ pint (8 oz.)—$1.98 ppd. Full pint (16 oz.)—$2.49 ppd. Amtech Creations, Dept. PS-R, 3511 Lawson Blvd., Oceanside, N.Y. 11572.

1964 PRESIDENTIAL SILVER Coin Set with scarce J.F.K. ½ dollars. Only set of this type minted by U.S. mint. Brilliant, uncirculated in gift case. Phila. or Denver mint $2.95 + 25¢ pp. Both mints 10 coins $5.50 + 25¢ pp. Free presentation case as illust. 10 sets $49.50; 20 sets $95. Free catalog. Novel Numismatics, 21-2nd Avenue, Dept. A-84, N.Y.C. 10003.



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Here are 88 imaginative, family-tested home designs, all in a full-color, 36-page book with easy-to-read floor plans. Each home is solid Canadian cedar, pre-cut to exacting standards. Part-numbered for quick, easy assembly. Each detail carefully finished, with the quality craftsmanship you'd expect from world's largest manufacturer of cedar homes. Wide range of sizes, prices. Shipping costs tailored to meet competition anywhere.

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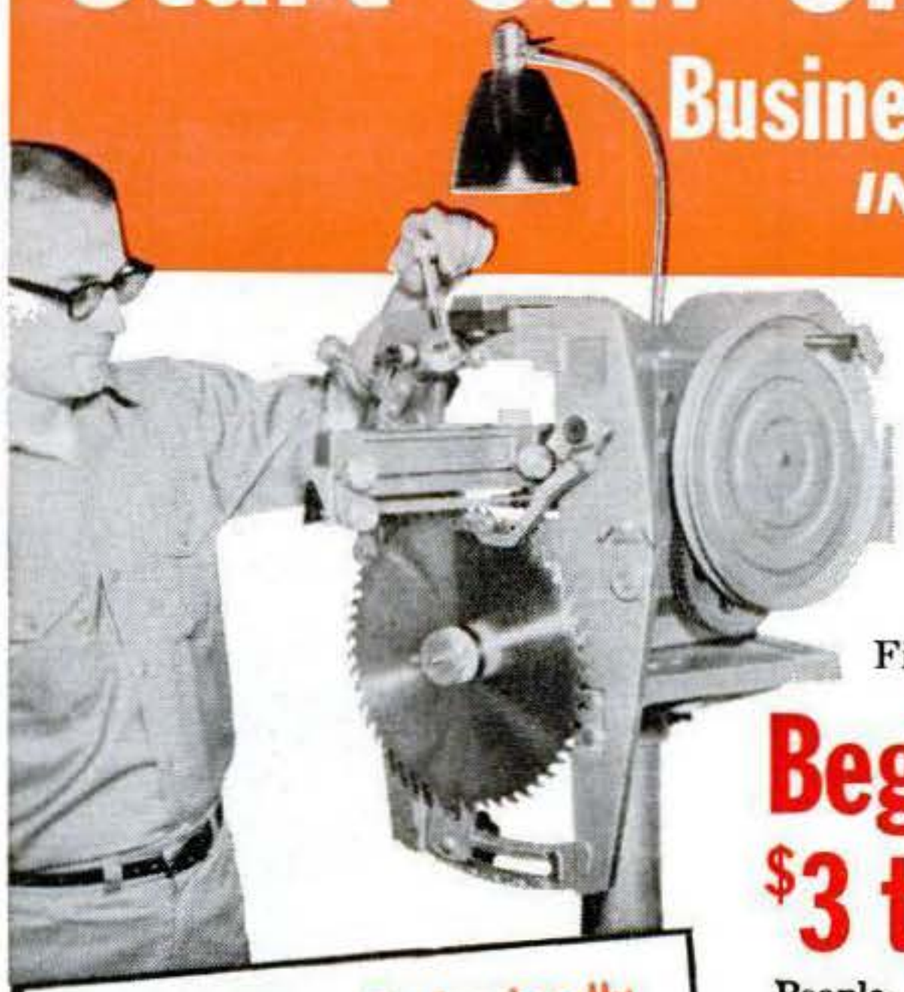
Need More Money? Want to Be Your Own Boss?

Start Saw Sharpening Business Of Your Own

IN YOUR SPARETIME

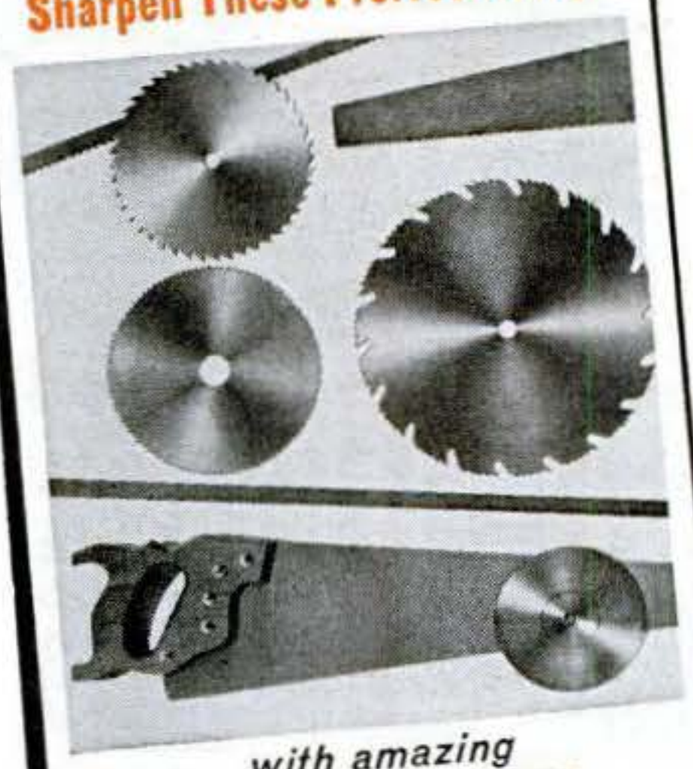


Turn your spare hours in the evening or weekends into extra dollars, this proven practical way—start your own money-making sharpening business—No selling or canvassing—No experience required. You can do it automatically with Foley Saw Filer or Lawn Mower Sharpener.

Beginners EARN $3 to $6 an Hour

People, just like yourself, all over the United States are making extra cash—$20 to $30 a week—right now in their spare time. "My sparetime saw filing business has made me $952 these first ten months," says R. T. Chapman. Many start part-time, find it so profitable that they build year-round service business. You can, too, simply by following easy Foley plan.

Sharpen These Professionally



with amazing

Foley Saw Filer

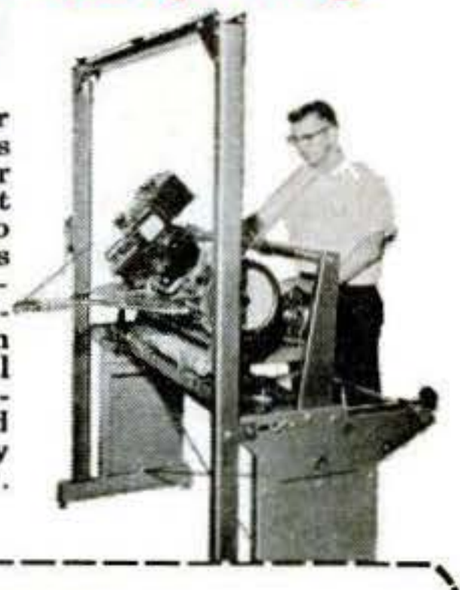
You can sharpen combination (rip and crosscut) circular saws, band saws, hand saws, crosscut circular saws—and do a perfect job every time without experience or special training. The precision Foley Filer does it for you automatically! A complete repair shop in one machine! Set up in basement or garage, work your own hours in your own way and earn big sparetime profits.

Town of 150 Supports Profitable Business . . .

Here's the story from Dick and Jo Ann Koester after being in business less than a year. "We have acquired another Foley Saw Filer and for the past two months we have been in full-time operation. As we live in a small town of 150 population in farm area we use our truck to pick up saws in five nearby towns. With a family to support and plans for building to our house we had to pick up a business fast and already sharpen an average of 15-20 saws a day. Business for the future looks even better as good machine filing is our best advertising."

CASH for Sharpening Mowers

Every neighbor with a lawn needs his lawn mower sharpened at least once a year. No experience is needed to start—anyone can operate and turn out professional jobs. All operations are handled quickly, easily and accurately.



MAIL COUPON TODAY!

FREE Booklet Tells How!

Free Book "Money Making Facts" shows just how you can start at home in spare time. Small investment—time payments if desired. Get this booklet—study it! Send coupon today. No salesman will call on you.

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Minneapolis, Minnesota 55418

Send Free Booklet on ☐ Saw Sharpening Business
☐ Lawn Mower Sharpening

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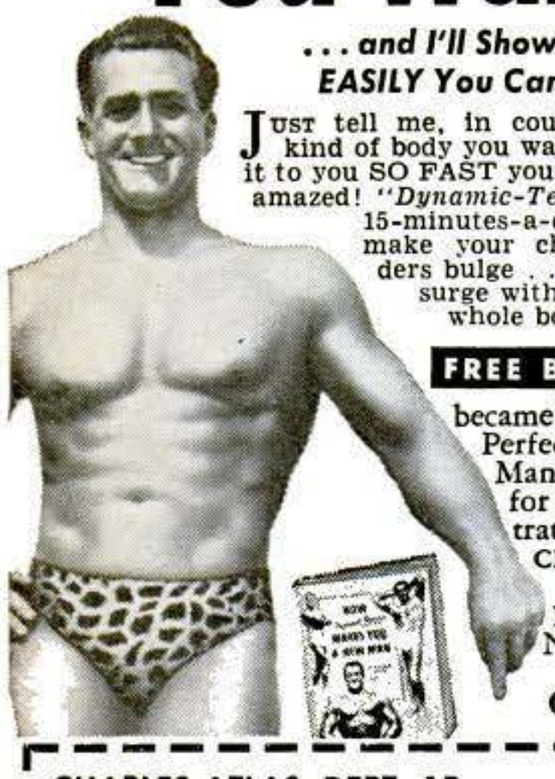
Check the Kind of Body You Want



. . . and I'll Show You How EASILY You Can Have It!

JUST tell me, in coupon below, the kind of body you want—and I'll give it to you SO FAST your friends will be amazed! *"Dynamic-Tension,"* my easy 15-minutes-a-day method, will make your chest and shoulders bulge . . . arms and legs surge with power . . . your whole body feel "alive"!

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(Check as many as you like)

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- ☐ **More Weight—Solid—in the Right Places**
- ☐ **Powerful Arms, Legs, Grip**
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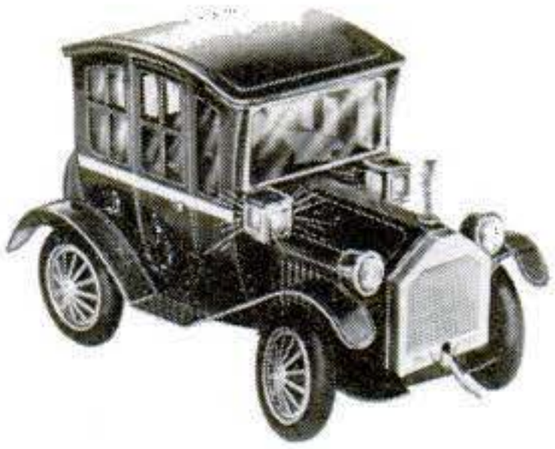
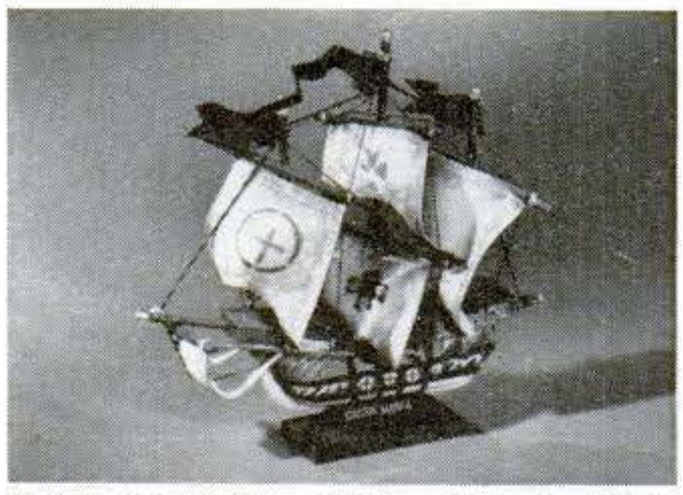
Shoppers' Showcase

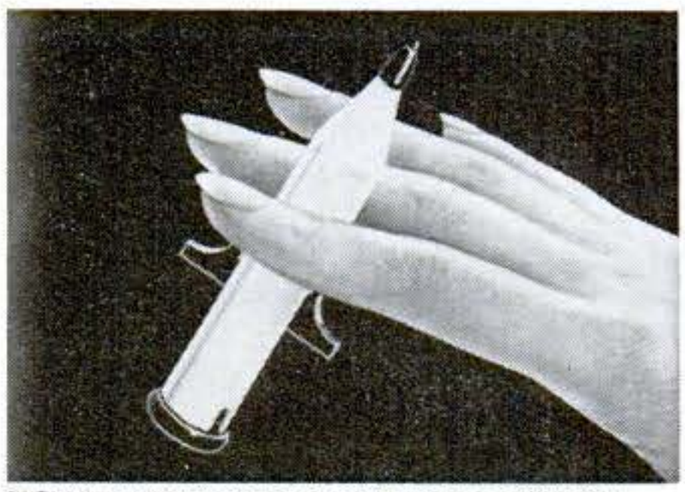


YOU'LL CHUCKLE the moment you see this magnificent replica, a 1916 Stevens. Swing the crank & it goes into action. Hear the motor, see it puff smoke, lights blink (runs in a circle). 9" long, 5¼" tall, rich maroon enamel, white, gold & brass trim. Uses 2 "C" cells. Great fun! $4.95 + 60¢ hdlg. World Co., Dept. 2PS, 1 Park Ave., New York, N. Y. 10016.

BUILD THIS MINI-BIKE yourself. No welding needed. Lightweight, rugged. Compares with the finest mini-bike you can purchase. Simple, inexpensive construction. Assemble with ordinary hobby shop tools. Illustrated plans, instructions & suppliers parts list. Satisfaction guaranteed. Plans only $2.00. Westate Enterprises, Dept. PS-2, Box 9216, San Jose, Ca. 95117.



HAND CRAFTED Nina, Pinta & Santa Maria to decorate your home or office. Each with its own distinctive lines, the historic fleet of Columbus, hand carved, hardwood & hand painted in traditional seaman's care. Santa Maria, 10" x 10" (shown here); Nina, 9½" x 8", and the Pinta, 7½" x 7". Complete set only $10.98 ppd. Colonial Studios, PS-2, 20 Bank St., White Plains, N. Y. 10606.



UGLY BLACKHEADS OUT IN SECONDS . . . a boon to troubled adolescent complexions & to a good many others as well is this small device, designed to remove even the most persistent blackhead in just a few seconds. Easily operated . . . its rubber tip makes operation a painless one. Made in U.S.A. beware of imitations. Vacutex is $1.50 ppd. Ballco Products Co., Dept. 46, 191 Main St., Westport, Conn. 06881.

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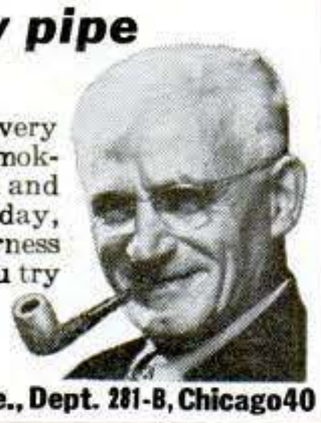

New principle that contradicts every idea you've ever had about pipe smoking. I guarantee it to smoke cool and mild hour after hour, day after day, without rest, without bite, bitterness or sludge. To prove it, I'll let you try a new Carey Pipe. Send your name and address today for my *free* complete trial offer. Write:

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Simple, sensible, Red-i-Kut shop tested plans. Build for yourself or sell at a good profit. SAVE 100's $$$. Narrow waist 83" tall models **"Spirit of the Century"** and new **"Spirit of Peace"** amazing console base or stately straight side **"CLASSIC America"**. Photopack Plans with *LIFE SIZE PATTERNS* tell all—plus *BUYER'S GUIDE*. Jet age heavy brass weight. (Kuempel original) Westminster Tubebell chime movements, gorgeous bronze-silver *Moving Moons* dials. **LYRE Pendulums,** finest solid ¾" kiln dried mahogany, walnut or cherry Jiffy Joint **Kwik-Bilt** case kits. $1.00 each plan. Rush $2.50 all three plus Bonus **"Petite Grandmother"** *plan*, as folks have for 50 years.

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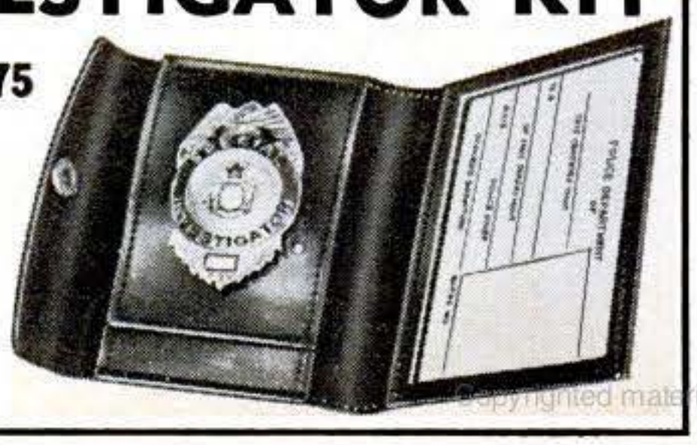
First time ever offered! Professional type detective badge kit and case. Includes professionally styled silver badge of extra heavy nickel for use by private and special investigators PLUS authentic type carrying case AND I. D. Card. Limited Supply, Order Now. Satisfaction Guaranteed or immed. refund. Only $2.75 plus 25¢ to cover post. & handling.



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YOUR OWN "MOONDUST"!

Looks like it, feels like it, performs like it. Simulated Moondust authoritatively corresponds in texture, color, overall appearance . . . even down to minute glass beads. Exclusively prepared by Dr. Thomas Gold, Director Cornell's Center for Radio Physics & Space Research—one of original scientists who analyzed actual lunar samples. Fascinating conversational item, great for study, experiments, contemporary education. Unusual soft, dark, powdery and cohesive substance—slightly adhesive. Two sizes.

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LONG-WAVE BLACK LIGHT FIXTURE

Extremely versatile, compactly designed, long wave (3200-4000 angstroms) black light (ultraviolet) fixture. Has 6-watt, 110-V lamp with built-in filter—eliminates harmful shorter wave ultraviolet rays. Use to identify minerals, fungi, bacteria—check for surface flaws, oil and gas leakage—perfect for displays with fluorescent paper, paints, chalk, crayons, trace powder. Incl. adjustable aluminum reflector, push-pull switch, connecting plug. Mount vert., hor., or on corner. 10" L., 11⅛" W., 1¼" H.

Stock No. 70,364N . . . . . $12.00 Ppd.
REPLACEMENT BULB
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4¼" ASTRONOMICAL TELESCOPE

See craters on the moon, rings of Saturn, double stars. New vibration-free equatorial mount. Mirror f/11, finished to better than ¼ wavelength. Gives theoretical limit of resolution. Rack-and-pinion focusing. Aluminum tube. 6x finder telescope. 2 standard eyepieces and Barlow lens give powers up to 225x. Free with scope: "Star Chart," 272-page "Handbook of the Heavens," "How To Use Your Telescope."

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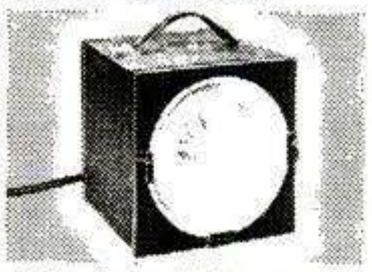
100 information packed pages! Fully explains latest in psychedelic lighting equipment, techniques, developments. Covers all facets of psychedelic light-show production including strobes, black lights, projectors, crystals, organic slides, mirrors, color organs, polarized color, light boxes, MusicVision, etc. Shows how to "psychedelize" parties, musical groups, shows or how to set up "electric trips" for private gatherings. 8½" x 11" looseleaf paper punched for 3 ring binder.

Stock No. 9100N . . . . . $3.00 Ppd.

CATCH THAT STROBE ACTION!



It's wild. Spectacular stop-action lighting effects will make a party, create a light show, turn the "swingers" into psychedelic performers. Top quality, low-cost, solid state electronic strobe. Adjustable flash rate from 2 to 16 flashes per second. Clear lucite lens protects long life Xenon lamp — up to 10,000,000 flashes. 60° high lustre reflector covers 2,000 sq. ft. area—even in dark of night-club. Rugged but compact (6" sq.) & lightweight (3¼ lbs.). Wrinkle-finished metal case. 110-120 V.AC.UP approved.

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Detect individual coins, rings as deep as 12"; bags of coins, tools to 3'; metal chests, safes to 6 feet. Best fully transistorized, induction-balance loop detector at moderate price. Rugged, lightweight (3½ lbs.) battery powered. Perfect for treasure hunters, collectors, explorers, beachcombers. Has visual and audible indicators, adjustable soil conductivity knob, on-off switch control. "Humsealed" solid state circuitry. 32" overall, adj. 11" diam. loop. Includes 9 volt (150 hr.) battery.

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MINIATURE WATER PUMP

Wonderful for experiments, miniature waterfalls, fountains, etc. Tiny (2⅝" x 1¾") electric motor and pump ideal for hobbyists, labs, schools. Pumps continuous flow of water at rate of one pint per minute at a 12" head. With two "D" batteries in series, will pump up to 24" high. Runs 48 hours on battery. Works in 2 directions. Self-priming.

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AMERICAN MADE OPAQUE PROJECTOR

Projects illustrations up to 3" x 3½"—enlarges them to 35" x 30" if screen is 6½ ft. from projector, larger pictures if screen is farther away. No film or negatives needed. Projects charts, diagrams, color or black-and-white. Operates on 115 volts A.C. current . . . 6 ft. extension cord and plug included. Size 12" x 8" x 4½" wide. Weight 1 lb. 2 ozs. Plastic case.

Stock No. 70,199N . . . . . $8.75 Ppd.

NEW BINOCULAR-TO-CAMERA HOLDER

Fits any camera for exciting telephoto pictures. 35-mm camera with 7 x 50 binocular brings distant object 7 times nearer. Ideal for long-range photos of wild life, ships, people, planes, etc. Attaches easily. Use any binocular or monocular—and camera—still or movie, color or black & white. Gray crinkle and bright chrome finish. 10" long. Full directions.

Stock No. 70,223N . . . . . $12.50 Ppd.

HOT-AIR FLYING SAUCER KIT

Giant 9 ft. model rises to amazing heights. Easy to assemble and launch. Use over and over. Low cost. Lots of fun. Can carry ½ lb. objects with string tether. Fly school colors at games, use for advertising, attach mirror—play "spy in the sky". Includes complete instructions, 16 pre-cut #1 white model paper gores, 8 red panels for portholes, wire, cord. Easily repaired if damaged.

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9 Ft. Hot-Air *Balloon* Kit
Stock No. 60,691N . . . . . $2.00 Ppd.

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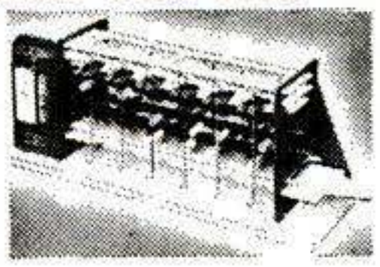

Solve problems, teach logic, play games with miniature version of giant electronic brains! Adds, subtracts, multiplies, shifts, complements, carries, memorizes. Colored plastic parts easily assembled. 12" x 3½" x 4¾". Incl. step-by-step assembly diagrams, 32-p. instruction book covering operation computer language (binary system) programming, problems & 15 experiments.

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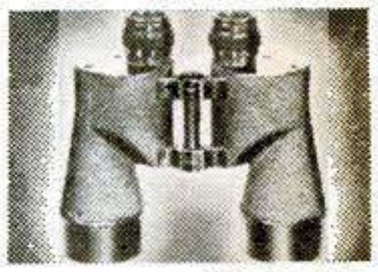

Big savings! Brand new! Crystal-clear viewing — 7 power. Every optical element is coated. An excellent night glass—the size recommended for satellite viewing. Individual eye focus. Exit pupil 7 mm. Approx. field at 1,000 yds. is 376 ft. Carrying Case included. American 7x50's normally cost $274.50. Terrific bargain.

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"Balls of fun" for kids, traffic stoppers for stores, terrific for amateur meteorologists. Create a neighborhood sensation. Great backyard fun. Exciting beach attraction. Amateur meteorologists use to measure cloud heights, wind speed and temp. Made of heavy duty neoprene. Inflate with vacuum cleaner or auto air hose; or locally available helium for high rise.

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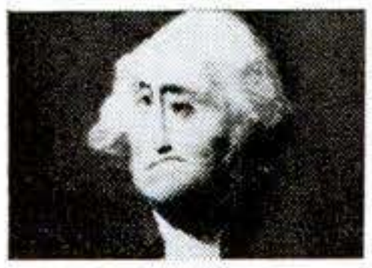

Now any amateur can produce all kinds of weird, wild, way-out photo effects. No special knowledge or equipment required. Unique kit enables you to turn friends into monsters, show house with water to 2nd floor, make psychedelic slides, kaleidoscopic photos, impressionistic photo-art—unlimited possibilities. Complete instructions. Includes all accessories needed.

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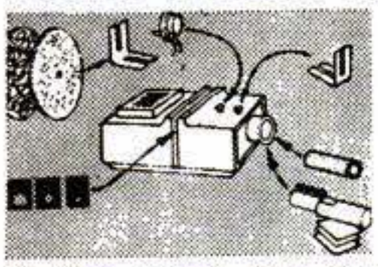
Brand new Signal Corps Electric Generator. Generates up to 90 volts by turning crank. Use in high impedance relays. Charge ground & bring up night crawlers for bait or study. 2 Alnico Magnets alone now worth more than original gov't cost of $15. Wt. 2 lbs.

Stock 50,225N . . $6.95 Ppd.
MOUNTED WITH LIGHT, TO DEMONSTRATE ELECTRICITY.
Stock No. 50,365N . . . . . $11.95 Ppd.

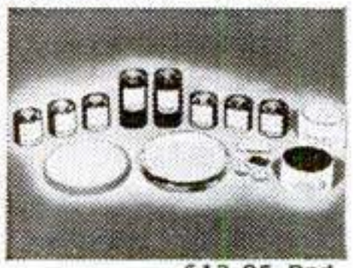
VISUAL EFFECTS PROJECTOR SET



Dazzling, avante-garde visual effects. Fantastic variety. Incredibly beautiful. Special package offer contains all necessary apparatus. Create floating, exploding, fiery bursts of color like "Symphony of Spheres", "Chromatic Starbursts", "Crystal Starburst". Features 35 mm 500 W. fan cooled projector—produces big image at short distance. Accepts two 9" diam. wheels (Dry Kaleidoscope & Hexidoscope). 2 cylindrical accessories (6" Colored Cloud & 5" Hexidoscope w/six internal mirrored walls). Perfect for entertaining parties, photography. Complete instructions.

Stock No. 71,212N . . . . . $79.50 Ppd.

ASTRONOMICAL TELESCOPE KITS



Grind your own mirror for powerful telescopes. Kits contain fine annealed pyrex mirror blank, tool, abrasives, diagonal mirror, and eyepiece lenses. Instruments you build range in value from $75 to hundreds of dollars.

4¼" DIAMETER—¾" Thick
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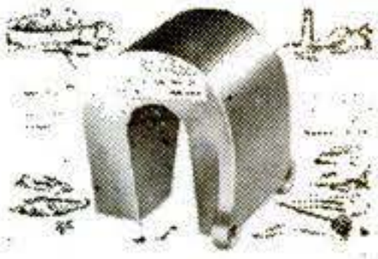

Go treasure hunting on the bottom! Fascinating fun & sometimes profitable! Tie a line to our 5-lb. Magnet—drop it overboard in bay, river, lake or ocean. Troll it along bottom — your "treasure" haul can be outboard motors, anchors, other metal valuables. 5-lb. Magnet is war surplus—Alnico V Type—Gov't cost $50. Lifts over 150 lbs. on land—greater weights under water.

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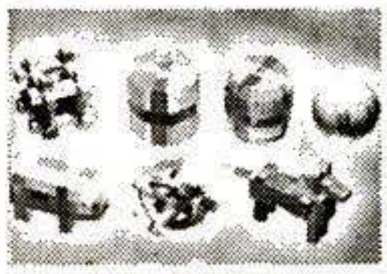

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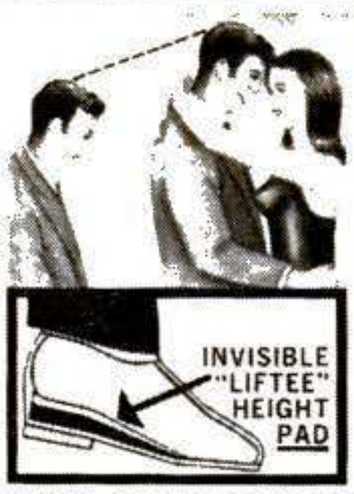

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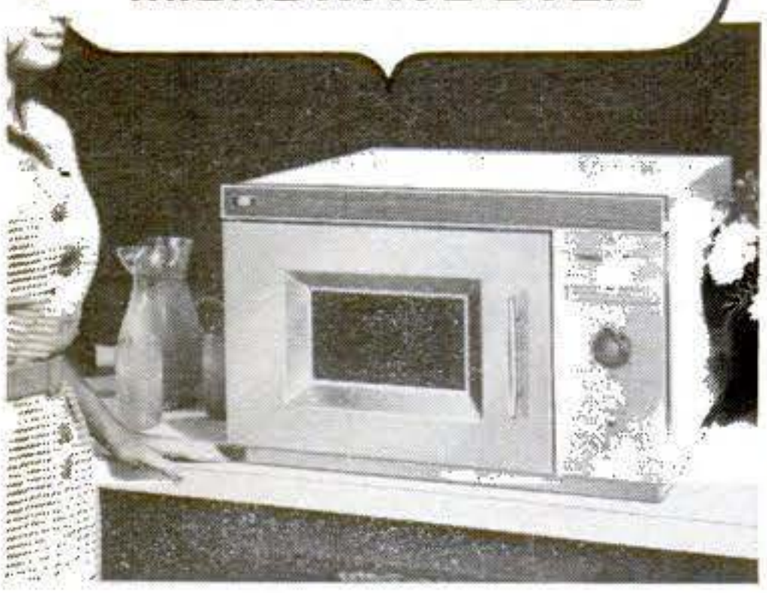

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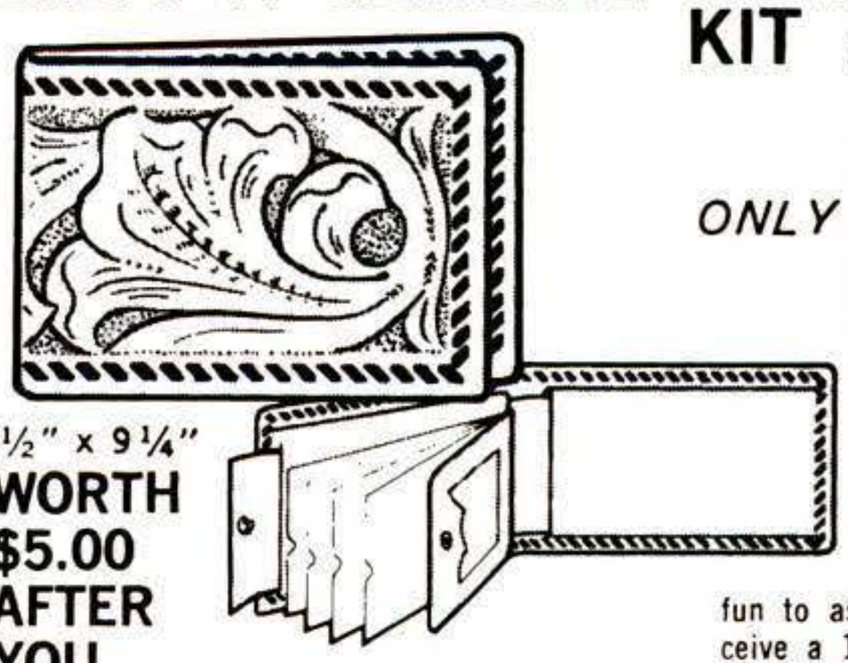

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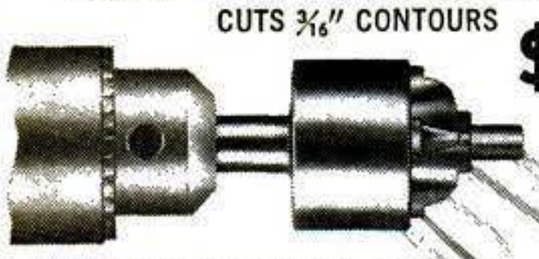

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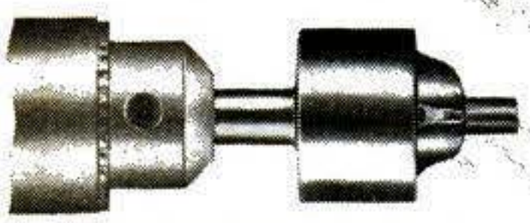

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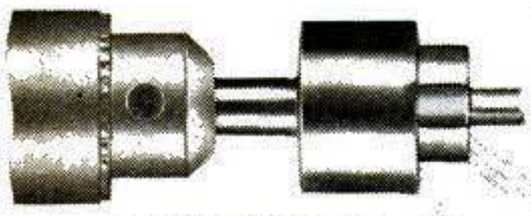

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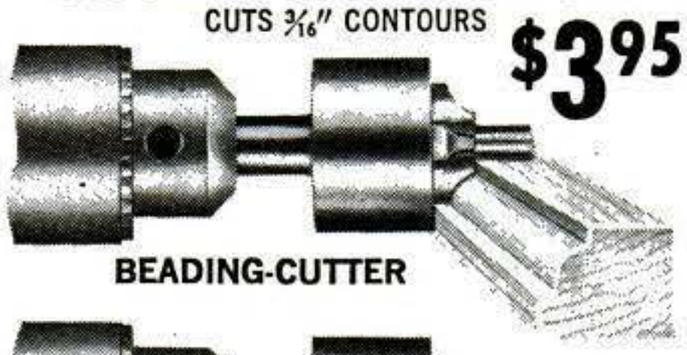

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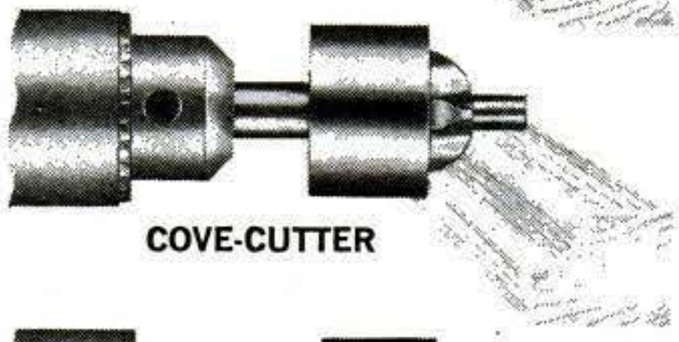

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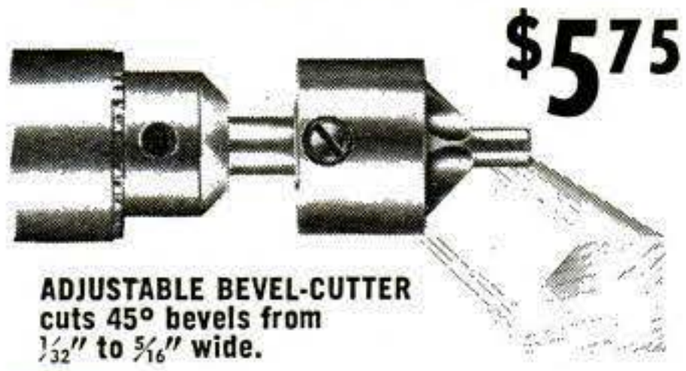

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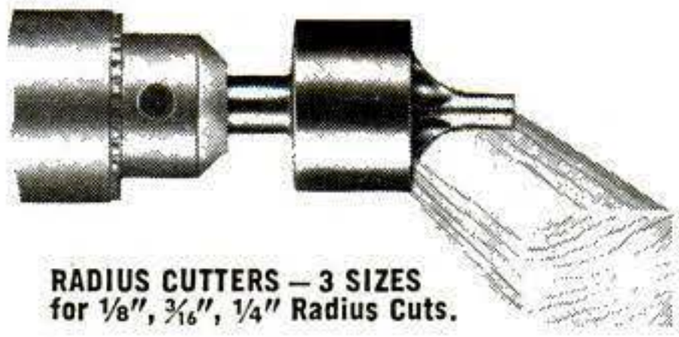

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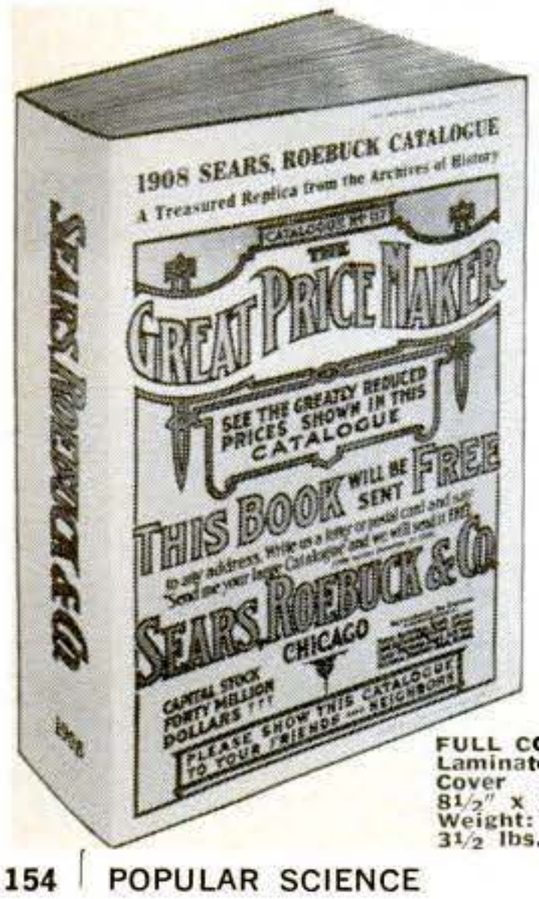

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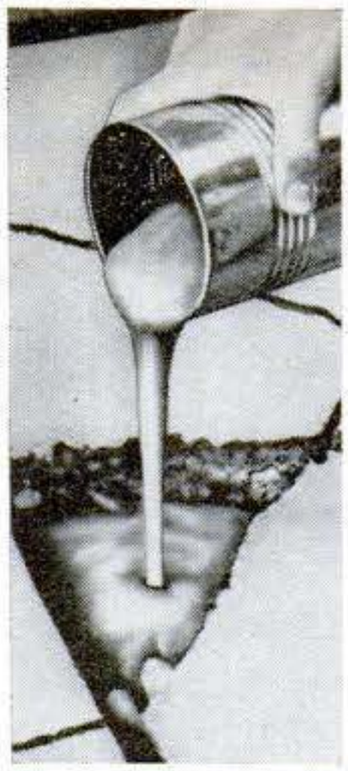

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If you're earning less than $1,000 per week, we think that you're selling yourself short.

The very fact that you're reading this says something important about you: either you are now in business for yourself, or you plan to be in the near future. If so, here's something for you to consider. As a self-employed individual, your earning power should be in the neighborhood of $1,000 per week, or about $50,000 per year.

We didn't just pull this figure out of the air. It's based on our years of working with people who work for themselves. What's more, common-sense arithmetic bears us out.

Not too many years ago, a man who was on his way to Success if he was earning $10,000 per year by the time he was 30. But times have changed, and that $10,000 figure has lost most of its glitter.

Today, many kids straight out of school command starting salaries of $12,000 to $15,000. By the time they're 30, those same young men are being paid $25,000 to 35,000 per year—working for somebody else. Which brings us to our conclusion: if you can make, say, $25,000 working for somebody else, you can make $50,000 working for yourself. Because you'll work harder, and you'll work longer hours, and because you won't have to split your earnings with bosses.

If this kind of arithmetic makes sense to you, and if self-employment is indeed your near-future goal, American Unifax would very much like to hear from you, because our success is based upon attracting the interest and support of persons like you.

We're in the office products field. When we entered this field, we did so with two important principles fixed in our mind.

The first of these principles was that we would offer for sale only those products which were demonstrably superior to any other products available from other companies, regardless of brand or price.

Our second principle was that we would make these products available to the business community through Direct Distributors—men who had the drive and determination to earn $50,000 or more per year.

We have never wavered from these two guiding principles, even though the kind of product we seek is rare, and the kind of man we seek is rarer still. As a result, we have enjoyed a steady, healthy growth, both in our merchandise line and in the team of Distributors which carries that line to the public.

It started with COPYFAX, our Space Age replacement for old-fashioned carbon paper. COPYFAX represents a totally new concept in multiple copying. Instead of the conventional combination of flimsy tissue and a carbon-grease-wax mixture, COPYFAX employs an incredibly strong film of DuPont MYLAR® only .001" thick, which, by means of a patented process, is treated with a liquid ink similar to that used by printers. One piece of ordinary carbon paper is good for about five rather smudgy copies before it's ready for the wastebasket. One sheet of COPYFAX gives as many as 200 crisp, clear, print-like copies—at about one-fifth the cost of carbon-paper copies.

Carbon paper is a $203 million industry in America. Steadily and surely, COPYFAX is taking over the lion's share of that industry.

COPYFAX is just one of our products. We've introduced the American Unifax Typing Ribbon, which is based on the same patented process that makes COPYFAX possible. And American Unifax Correction Paper, a unique solvent-ink paper that makes correcting typing errors almost unbelievably easy. More new products are on the way.

In selecting our Distributors, we exercise the same care as in selecting our products. It seems to us that our kind of company—dynamic, flexible, and doing a very high sales volume—is better off with one man who demands $1,000 per week than with five men who'll be happy with $200, or with ten who'll settle for $100.

This is not to say that the bulk of our Distributors come from the ranks of the supersalesmen. Quite the contrary. One, for example, is a bank manager who makes over $300 a week in his spare time, selling COPYFAX through the mail. Another is a printer who, with our help, has recruited over 100 sub-distributors who sell for him. A third, a housewife, had "never sold a thing in her life"—but who landed a $785 order in less than five minutes.

Another thing about our company which might interest you—we don't charge franchise fees. We believe that your effort, interest, and loyalty are more valuable to us than any fee we could reasonably ask from you. Therefore we don't ask for any fee at all.

These are some of our principles and attitudes. We intend to stick by them, because they work. In two short years, American Unifax has grown into a company of major importance in the office products field. And we're growing faster all the time.

We'd like you to grow along with us. We won't guarantee that you'll make $1,000 per week, but we promise you this: we'll give you all the tools you need to earn that much money. And if you're the kind of man we hope you are, you'll know how to use them.

AMERICAN UNIFAX, INC. Dept. PS27
95 Madison Avenue,
New York, New York 10016

The American Unifax way of doing business makes sense to me—give me the tools to start making $1,000 per week.

☐ Rush complete information, FREE and without obligation.

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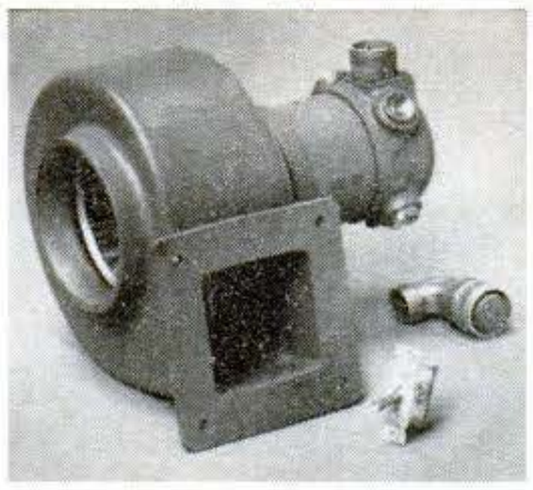

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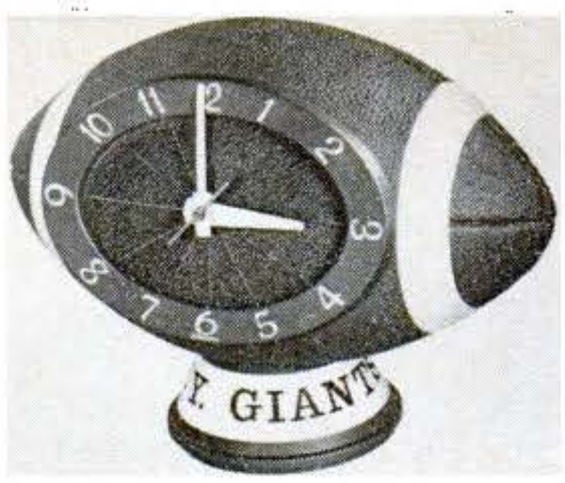

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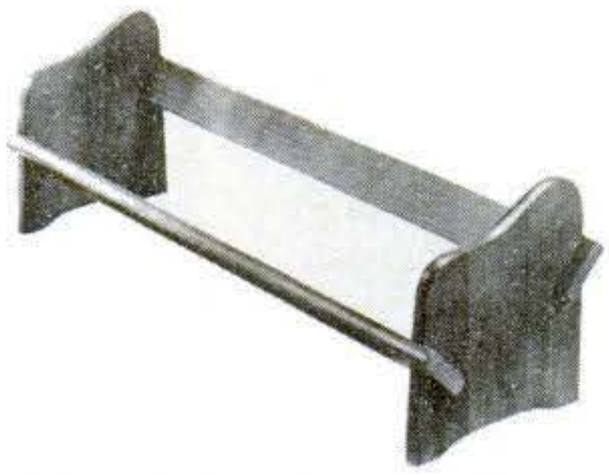

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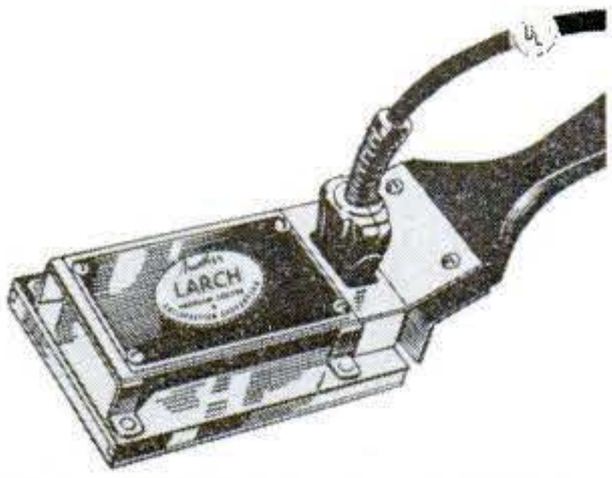

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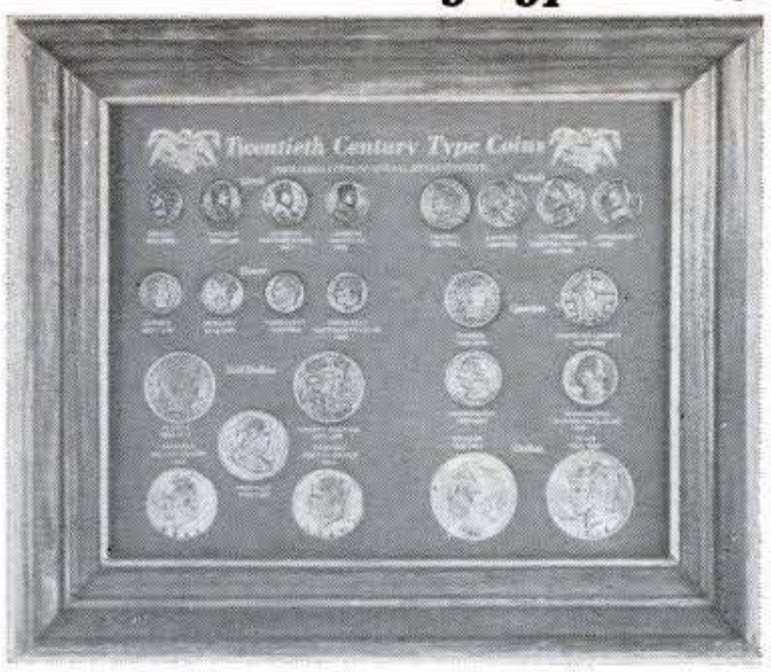

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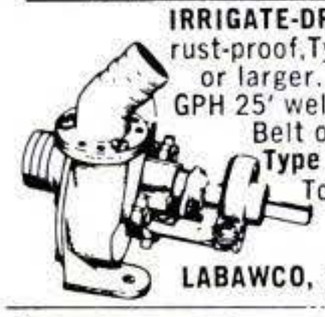

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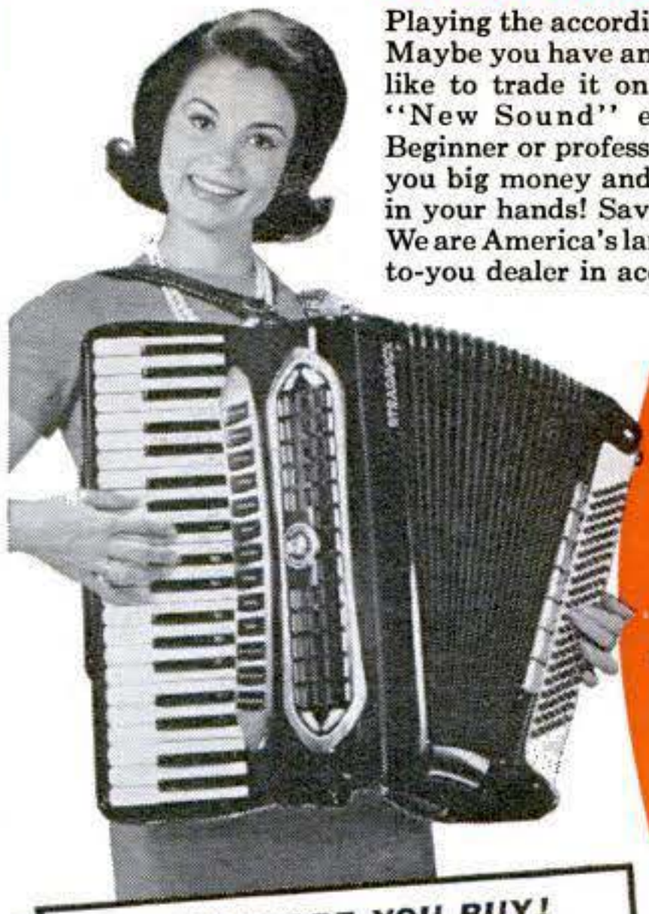

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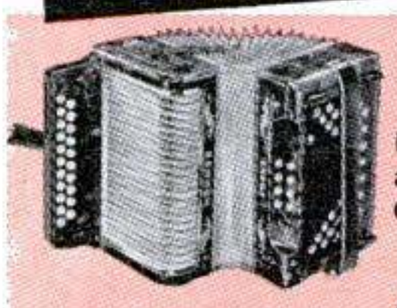

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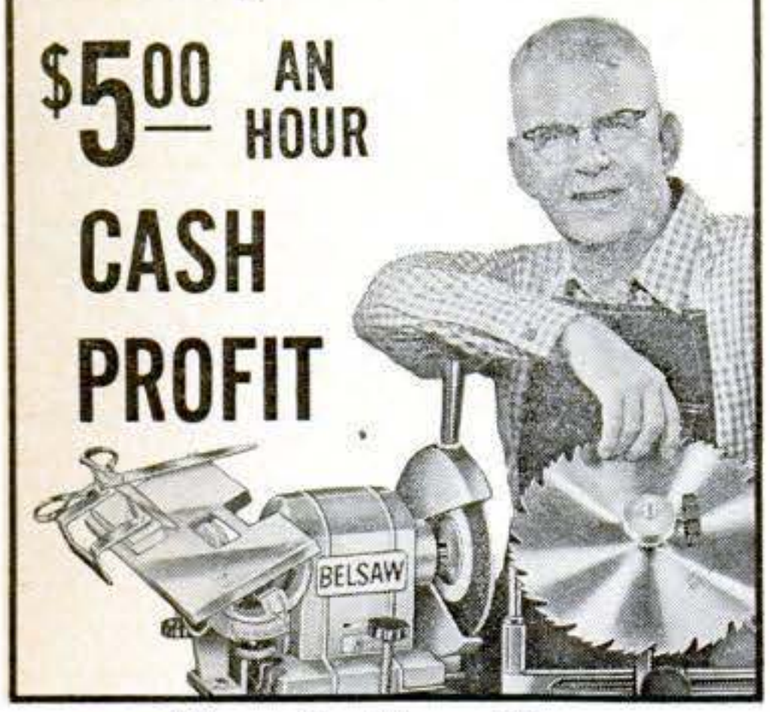

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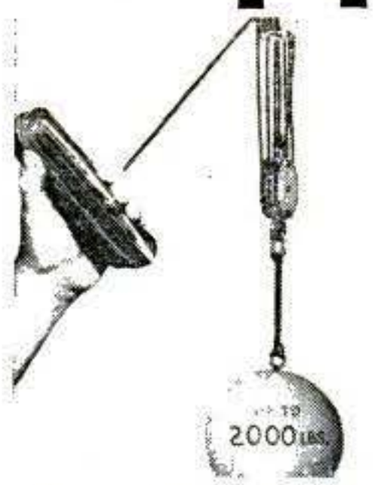

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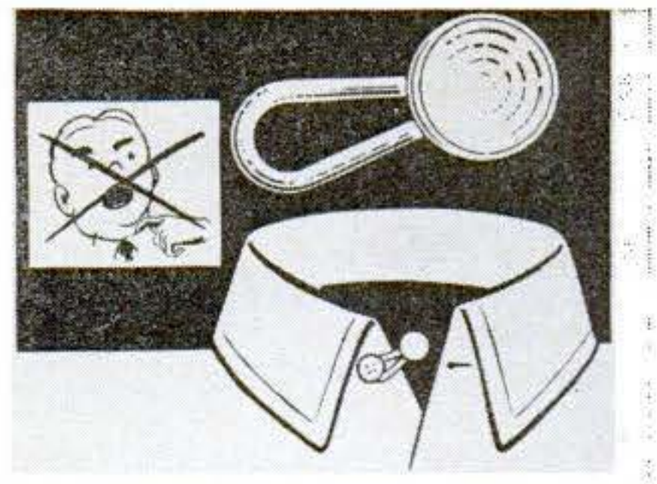

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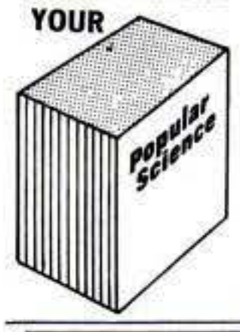

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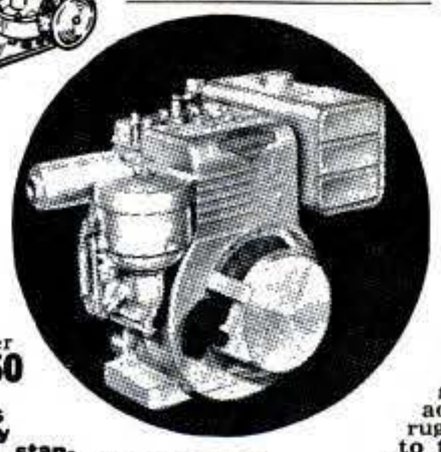

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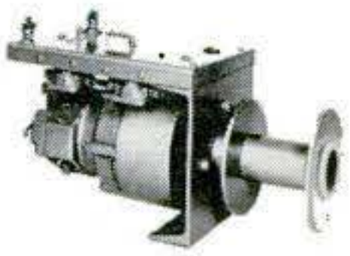

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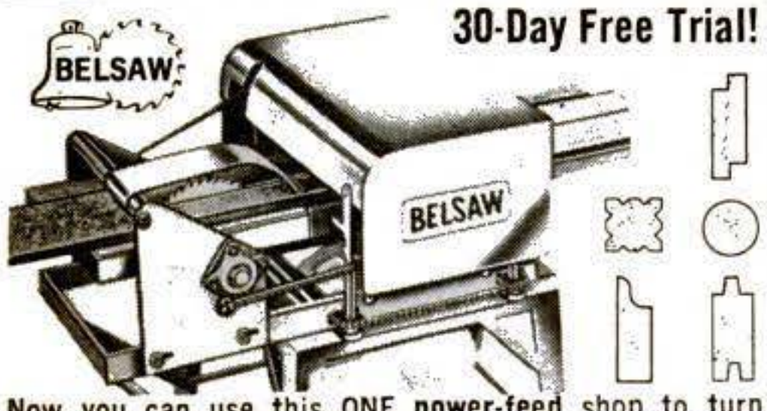

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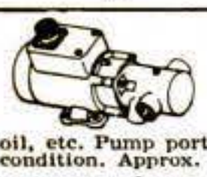

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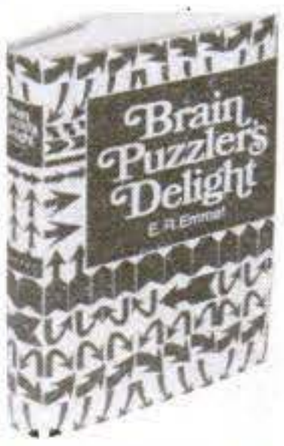

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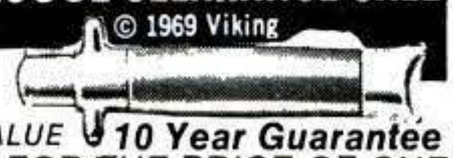

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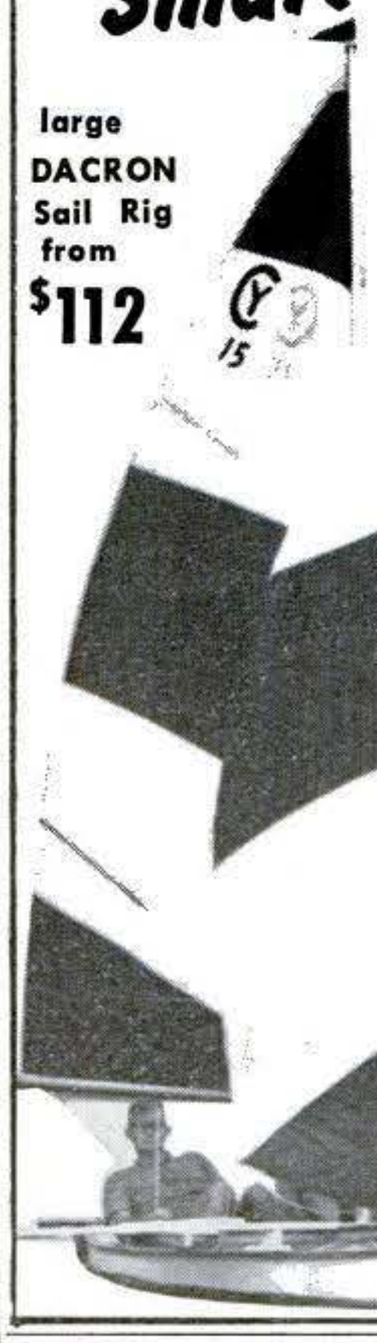

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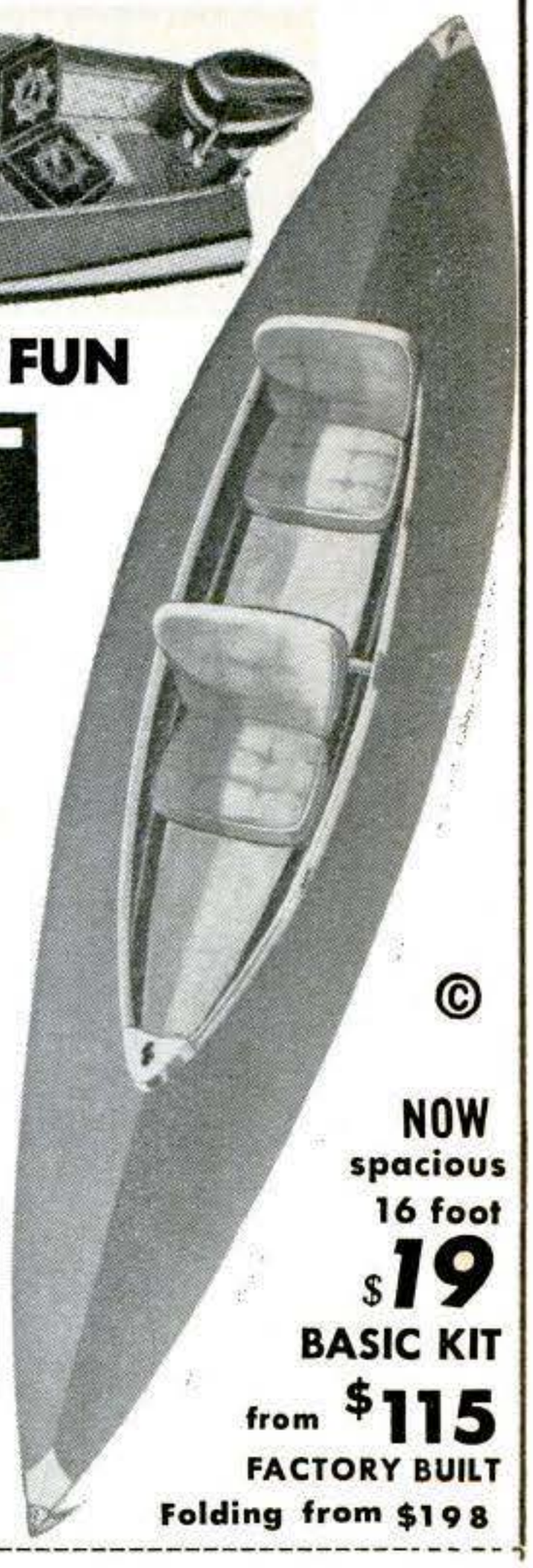

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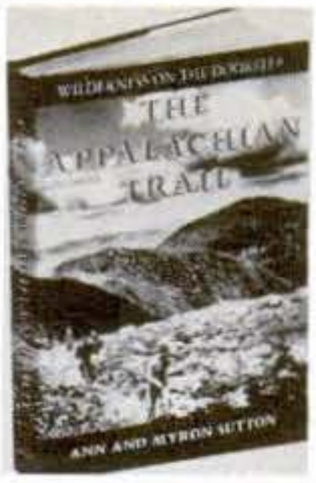

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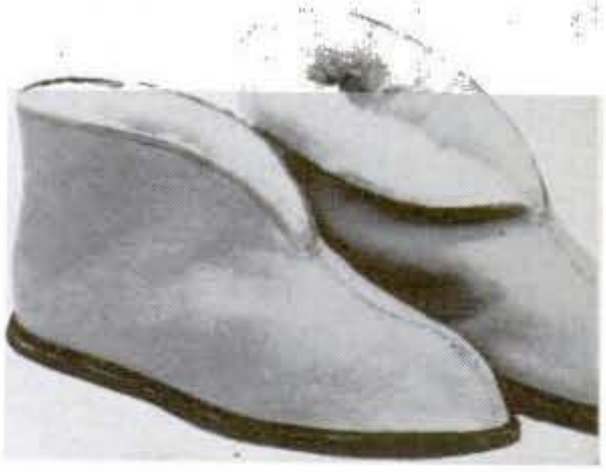

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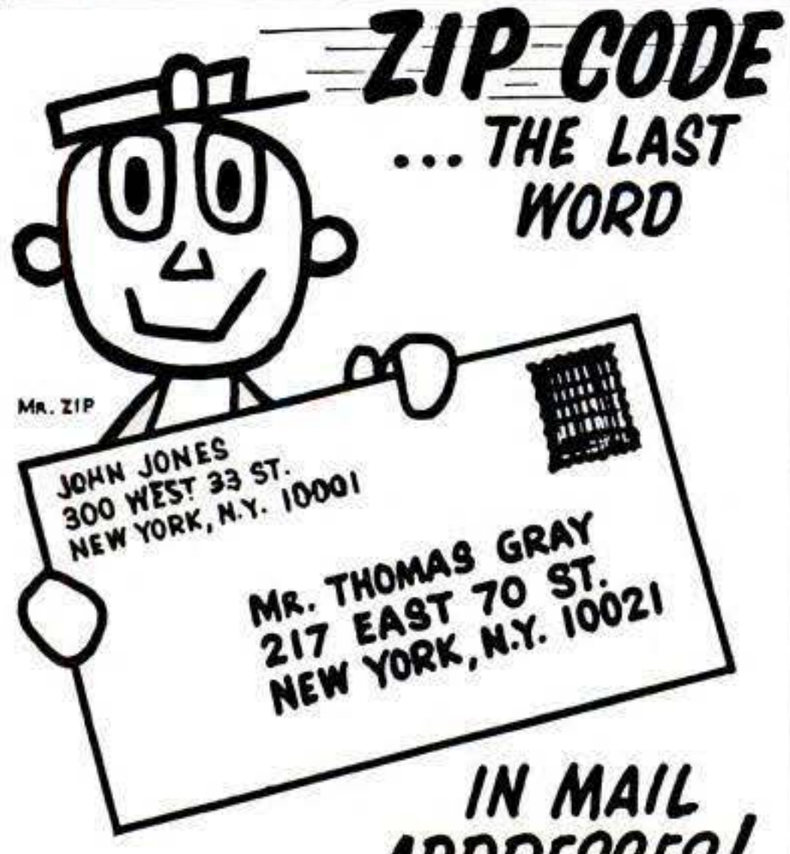

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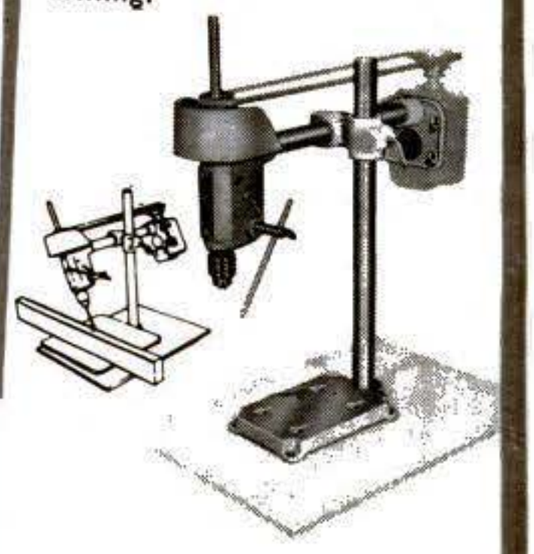

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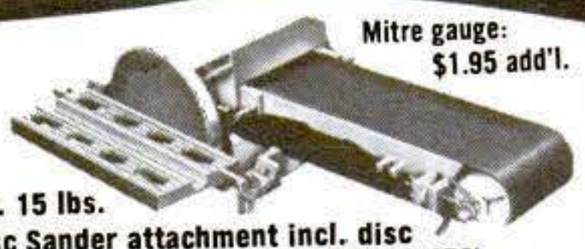

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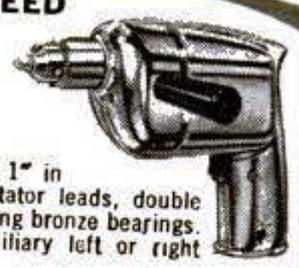

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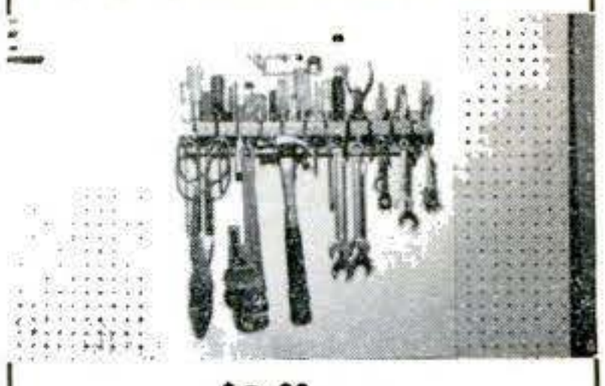

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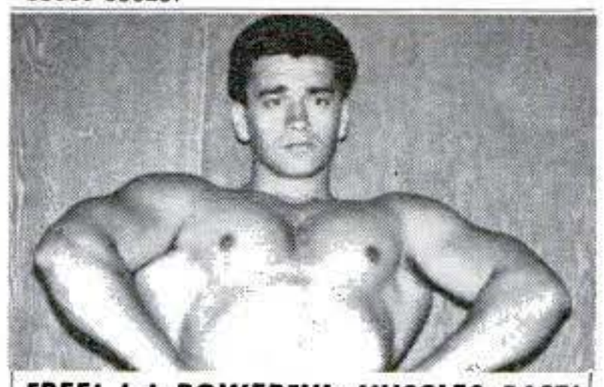

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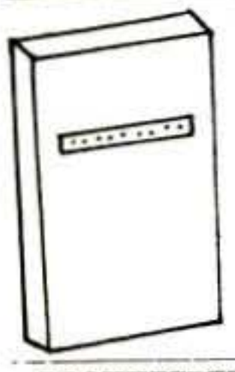

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